LEON HEAT TREATMENT FOR DISTORTION CONTROL

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LEAN HEAT TREATMENT FOR DISTORTION CONTROL
Proper control of heat treat distortion is of key importance to reduce production costs in gear manufacturing.
By DR. VOLKER HEUER AND DAVID BOLTON

IS ANYONE PRINTING GEARS USING METAL ADDITIVE MANUFACTURING?
AGMA’s Emerging Technology Committee has found that additive manufacturing, particularly 3D printing, has the potential to provide many opportunities for gear manufacturers.
By MARY ELLEN DORAN

A LEADER ON HIGH-QUALITY INSTALLATIONS

COMPANY PROFILE  For nearly 50 years, Artec Machine Systems has been trusted for engineering design, parts, field repair, and maintenance of all types of heavy gear systems.
By KENNETH CARTER

TOOLING & WORKHOLDING

MAKING OUT-OF-ROUND PARTS ROUND
Several methods are available to face the difficulties presented by today’s thin-walled parts.

‘WE MUST NEVER STAND STILL’
Metrologists take on new, frequent challenges for quality control.
Manufacturers of:

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HOW TO SET-UP A VIBRATORY BOWL FOR GEAR FINISHING

Open or tight roll patterns, bowl motions, rolling speed, and alignment angles are among possible adjustments to get optimal mass motion.

STANDARDS IN TERMINOLOGY FOR BEVEL GEARING

Knowing the proper terminology is key for understanding bevel gear design.

BACK TO BASICS: THE MECHANISM OF QUENCHING

Hot components are cooled down during contact with the liquid quenchant, normally through three stages.

New features announced for Motion + Power Technology Expo.

Leek Gears installs 4-axis machining center at Staffordshire site.

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

American Gear Manufacturers Association

MATERIALS MATTER

WILLIAM P. NEBIOLO

HOW TO SET-UP A VIBRATORY BOWL FOR GEAR FINISHING

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

TOOTH TIPS

BRIAN DENGEL

STANDARDS IN TERMINOLOGY FOR BEVEL GEARING

HOT SEAT

D. SCOTT MACKENZIE

BACK TO BASICS: THE MECHANISM OF QUENCHING

PRODUCT SHOWCASE

50

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

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COVER PHOTO: SHUTTERSTOCK / ILLUSTRATION BY RICK FRENNEA
For a long time now, Gear Solutions has been a source of news and information about four important aspects of the gear-manufacturing industry: tooling & workholding and inspection & metrology.

This issue includes articles, product announcements, and listings for these topics that will serve as a valuable resource and a quick guide that can be used throughout the year. It's basically a mini-Buyer’s Guide for the gear-manufacturing areas.

For years, we have offered readers a separate supplement, but this time, we decided to try something a little different. Instead of offering a separate issue highlighting these subjects, we combined them into one issue. It’s an easy, one-stop-shopping way to check out the information, as well as the company listings you’ve come to expect.

You’ll also notice a tab system that separates each bonus section. Each section has a folded tab that can be extended to offer you quick and easy access. I hope you think it’s as cool as we do, so please let me know if you like the new format.

By focusing on tooling, we hope to bring you some in-depth knowledge on machine tooling, improving efficiency, performance, and precision in gear manufacturing. Improvements in tooling are happening all the time, it seems, so we want you to stay informed of the latest news and developments.

Inspection and metrology markets have been making a lot of strides in automation, data collection, and results analysis. Whether it involves a large OEM, major tier supplier, or a small job shop, these technologies can benefit practically any company.

But this issue isn’t just about tooling & workholding and inspection & metrology. The regular part of our July issue offers several interesting looks at gear manufacturing.

Heat treating gears is often an essential step in the manufacturing process. In our Focus section, Dr. Volker Heuer and David Bolton share their insights on lean heat treatment for distortion control.

And in a fascinating article looking at innovative technology, Mary Ellen Doran, director of emerging technologies for AGMA, takes a deep dive into additive manufacturing — particularly 3D printing — and how companies must take a serious look at what this technology has to offer, both now and in the future.

July has become one of Gear Solutions' most diverse months when it comes to the information you’ll find. I hope you discover something you can use, and maybe even learn something new along the way.

So, enjoy our regular features, as well as our bonus sections. If there is a topic you’d like to see more of, please reach out to me. I would love to hear from you.

Also, please contact us if you would like to add your company to the listings.

As always, thanks for reading!

KENNETH CARTER, editor
editor@gearsolutions.com
800-366-2185 x204

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New features announced for Motion + Power Technology Expo

The trade show floor will feature the Fluid Power Pavilion and an Emerging Technology Pavilion with solutions focused on IIoT, blockchain, 3D printing, robotics, supply chain, and more.

The Motion + Power Technology Expo (MPT Expo), formerly Gear Expo, will be October 15–17 at the Cobo Center in Detroit, Michigan. More than 17 percent of the participating companies are brand new to the event, and 10 percent of those are international. 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.

“With our move to Detroit and new positioning for the event, we have been able to attract some of the larger companies in this space to participate, including FANUC, J.G. Weisser Söhne, and Philadelphia Gear, who will join over 300 exhibiting companies to showcase the latest products, services, and solutions for mechanical power transmission, fluid power, and electrical drive industries,” said Jenny Blackford, vice president, marketing, AGMA. “We deliver a high-quality audience of 4,000 industry professionals from the mechanical, electric, and fluid industry from around the world to meet with our exhibitors and sponsors, and are looking forward to another dynamic event.”

There are 39 companies exhibiting for the first time at the Motion + Power Technology Expo in Detroit. Some big names include drivetrain supplier Dana Incorporation, IoT supplier MachineMetrics, and milling machine supplier WFL Millturn Technologies GmbH & Co. Other first-time exhibitors include Gear Motions Inc. of New York, Global Gear of Illinois, as well as Knoll America and Laser Marketing Technologies, which are both based out of Michigan.

The trade-show floor will also feature the National Fluid Power Pavilion, sponsored by NFPA, which will feature more than a dozen companies including Casappa Corporation, CSB Americas Inc., DMIC, Donald Engineering, Dura-Bar, FluiDyne Fluid Power, IC Fluid Power, Inc., Lucrecent Bearings, OEM Controls, Peninsular Cylinder Company, R&J Cylinder and Machine, Terzo Power Systems, Tribute, Inc., TTP-API Heat Transfer, Tuson Corporation, and Yates Cylinder.

Back by popular demand to the show floor will be the Emerging Technology Pavilion as a way for companies to showcase the latest products in 3D printing, robotics and more. For additional information about exhibiting in this new pavilion, email Jenny Blackford at blackford@agma.org.

The Motion + Power Technology Expo (MPT Expo) will bring together more than 4,000 professionals looking for technical solutions from more than 300 exhibitors across the supply chain, including gear...
companies, machine tools suppliers, and electric drive solutions showcasing new products and services from industry leaders. Attendees will learn from industry experts on the hottest topics including cybersecurity, supply chain, 3D printing, robotics, and much more in a two-track seminar series called the MPT Conference. The Motion + Power Technology Expo will also offer the AGMA Fall Technical Meeting and short course technical seminars from AGMA and NFPA in several education seminars. There will also be networking receptions, private meetings, one-on-one time with suppliers, exchanges in the education sessions, and mingling with colleagues on the show floor.

MORE INFO www.motionpowerexpo.com

Sandvik names Johan Salwén technical marketing specialist

Sandvik has announced Johan Salwén as technical marketing specialist for the EMEA region. He will be based at Sandvik’s sales office in Kista, Sweden. His role will primarily be looking after the EMEA region, while also supporting product management and R&D projects. Part of this activity will involve joint visits with the sales teams to customers’ premises to assist and advise on the appropriate material selection for a range of corrosion issues.

He returns to Sandvik following a year working as an application engineer for metallurgy with a heat-treatment company based in Sweden. Before this, he worked for Sandvik Materials Technology for seven years, based in Sandviken, where he held a number of roles, mainly on the research and development side of the business. These included R&D responsibilities in the tube department as a development engineer, then process engineer. He later became R&D development engineer in the welding department, and later took the role of senior R&D development engineer.

Salwén has an International Welding Engineer (IWE) diploma from KTH. He has great experience and knowledge of different welding techniques and welding of a large range of materials, from carbon steels to highly alloyed stainless steels and nickel alloys.

Barinder Ghai, regional technical marketing manager - EMEA application products for Sandvik, said, “We are delighted to have Johan back within the Sandvik ‘family’ as he brings with him a wealth of industry experience, having previously worked in engineering positions involving stainless steel materials and metallurgy with fertilizer, welding and heat exchanger applications. We are confident he will have a significant contribution to make to our technical sales and marketing activities moving forward.”

After studying at the Royal Institute of Technology in Stockholm, Salwén achieved a Master’s degree in materials science.

MORE INFO www.materials.sandvik

Motion Industries promotes John Watwood to senior VP

Motion Industries, Inc., a leading distributor of maintenance, repair, and operation replacement parts and a wholly owned subsidiary of Genuine Parts Company, has named John Watwood group senior vice president of the company’s Southeast group effective May 1, 2019.

A graduate of the University of North Alabama (MBA) and University of Alabama at Birmingham, (BS, industrial distribution/marketing), Watwood has more than 20 years of experience in the industry. He has worked in various positions with AIT, Fluid Engineering, and SMC before joining Motion Industries in 2008 as a fluid power specialist based out of Mississippi. Watwood quickly worked his way up to branch manager positions in Columbus, Mississippi, and Nashville, Tennessee, before earning a promotion to division vice president, general manager of the Nashville division in 2014.

Kevin Storer, Motion Industries executive vice president U.S. operations, said, “John’s experience, expertise, and leadership style are well-suited for this expanded role and will allow him to move with agility toward success. We are excited that he has accepted the challenge to grow our Southeast market and enhance our initia-
INDUSTRY NEWS

4-axis machining center
With a travel axis of 750 x 440 x 500 mm, ground in precision gear manufacturing,
the new addition will help us to service a
larger customer base and reach out to new
markets. The Leek Gears factory and is
employed at the Leek Gears factory and is
part of an ongoing investment program to
to increase the capabilities and capacity of the
business.

The new machine will allow the business
to undertake more complex milling tasks
quicker, more accurately and, ultimately, at
lower cost to its customers.

Leek Gears has been operating since
more than 100 years and originally traded
as Charles Leek & Sons. With a strong back-
ground in precision gear manufacturing,
Leek Gears has been successful in markets
such as oil and gas, agricultural machinery,
quarrying, and power generation. It also
has considerable expertise in the manufac-
ture of gears for steam engines and vintage
motorcars, where owners appreciate the
authenticity of some of its older gear cutting
machinery.

Managing Director Cristina Talens
said, “We are delighted to be investing in
a new CNC machine at our factory in Leek.
The new addition will help us to service a
larger customer base and reach out to new
markets. The Leek Gears business has been
undergoing a strategic growth project focus-
ing on developing key areas of the business
to enhance the service we can offer to our
customers. This includes offering gearbox
refurbishment as a service, a complete fac-
tory 55 project, and a strong focus on strate-
gic marketing and brand awareness.”

Mazak expands state-of-the-art spindle
rebuild center

With the expansion of its industry-leading
Spindle Rebuild Department, Mazak will
reset the bar for efficiency and quality in
OEM-factory-certified spindle rebuild ser-
tices. The expanded and newly updated
department, which will now be in the South
Building on Mazak’s Kentucky manufactur-
ing campus, will further improve the com-
pany’s ability to quickly deliver spindles and
reduce customer downtime.

The grand opening of the new Spindle
Rebuild Department will take place during
the company’s DISCOVER 2019 event, which
will be held November 4-15 at the Kentucky
manufacturing campus. As the largest pri-
ivate manufacturing event in North America,
DISCOVER 2019 will present attendees with
new technology, advanced manufacturing
solutions, and valuable industry insight to
increase operational efficiency and global
competitiveness.

DISCOVER 2019 attendees will have the
opportunity to tour the Spindle Rebuild
Department, which supports every Mazak
machine tool spindle in North America —
more than 2,000 different models covering
a wide range of horsepower ratings and speeds. As a cost-effective option for
its customers, the expanded department
will keep upwards of 1,000 rebuilt spindles
in stock and ready for exchange, particu-
larly those found in Mazak’s most popular
machine models.

To guarantee that all original spindle
specifications are met or exceeded, expe-
rienced factory-trained technicians use
only genuine Mazak replacement parts to
rebuild Mazak spindles. These experienced
technicians perform every stage of the
repair and rebuild process, provide com-
plete trackable spindle documentation and
conduct stringent testing of every spindle,
all within the short turnaround time. The
expansion will not only make room for
additional technicians, but will also allow
the department to boost its rebuild output
to 100 spindles per month.

“Mazak’s Spindle Rebuild Department
leverages over 30 years of spindle build
expertise to offer the industry’s best spin-
dle warranty,” said Matt Whisell, spindle
repair manager for the Mazak Spindle
Rebuild Department. “We understand our
customers don’t have time to wait, and
Mazak is truly committed to doing what-
ever we can to support these customers. And
with our new facility, we have the capacity
to return repaired spindles in three to five
days and ship remanufactured spindles in
less than 24 hours.”

To reach that level of efficiency, Mazak
has significantly expanded the new spindle
department’s work area, and the clean, bright,
and ergonomic workspace will streamline
rebuild operational flow, efficiency and speed,
as will its closer proximity to the Mazak Parts
Department in the South Building. To further
streamline its spindle rebuild process, Mazak
has also incorporated new advanced technol-
ogies, including spindle balancing units and
other process systems intended for accommo-
dating larger spindles.

MORE INFO www.leekgears.co.uk

MORE INFO www.mazakusa.com

Mazak expands state-of-the-art spindle
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other process systems intended for accommo-
dating larger spindles.

MORE INFO www.mazakusa.com

Leek Gears installs
4-axis machining center
at Staffordshire site

Gear manufacturing specialists and preci-
sion engineers at Leek Gears installed its
first 4-axis machining center at its factory in
Leek, Staffordshire. The XYZ 750 LR machine
was installed in May and will step up Leek
Gears’ CNC machining capabilities, increas-
ing opportunities in its UK markets.

The 750 LR machine will be used to
machine a range of high-precision parts.
With a travel axis of 750 x 440 x 500 mm,
the machine will handle the majority of
work coming through the factory. The
new machine complements the range of
Haas and Colchester CNC lathes currently
employed at the Leek Gears factory and is
part of an ongoing investment program to
increase the capabilities and capacity of the
business.

The new machine will allow the business
to undertake more complex milling tasks
quicker, more accurately and, ultimately, at
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refurbishment as a service, a complete fac-
tory 55 project, and a strong focus on strate-
gic marketing and brand awareness.”

MORE INFO www.leekgears.co.uk

MORE INFO www.motionindustries.com

Leek Gears installing 4-axis machining center at Staffordshire site

Leek Gears managing director Cristina Talens and production manager Mick Harvey with the new machine. (Courtesy: Leek Gears)

The XYZ 750 LR vertical machining center. (Courtesy: Leek Gears. Copyright XYZ Machine Tools.)

Motion Industries President Randy Breaux said, “John brings an intensity we need in the current market, along with the
ability to drive strategic change through efficient operational execution. We look forward to seeing the Southeast Operating Group’s future accomplishments resulting from his influence.”
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COM Basic and Expert interface to integrate KISssoft software

The use of several software tools in the gearbox design process is a common challenge for engineers. The rising need for simple communication between different CAE software is becoming a trend along with the Industry 4.0.

The COM (Component Object Model) that was developed by Microsoft offers the possibility for simple communication between different programs. KISssoft software offers the COM Basic (Module CC1) and the COM Expert (Modules CC1 + CC2) interface modules to integrate KISssoft into the engineering process chain.

The COM Basic Interface allows simple KISssoft calculation calls and parameter transfers as well as KISssoft results from external programs such as MS Excel, MATLAB, C++, PHP, Java, Python etc.

The COM Expert Interface additionally allows more complex KISssoft functions such as rough and fine sizing, contact analysis, etc. and output of the calculation results in simple text format.

To learn more about this topic, take part in the KISssoft User Meeting International 2019 on October 23-24. (Courtesy: KISssoft)

Jergens, Inc. appoints national sales manager for workholding

Cleveland, Ohio, based Jergens, Inc. announced that Ken Marvar has assumed the role of national sales manager, Jergens Workholding Solutions Group.

“ln his new role, Ken is responsible for the sales of our workholding products through our network of partner distributors and for the management of our national network of manufacturers’ representatives,” said Jergens General Manager Matt Schron.

Marvar has more than 40 years of sales management and customer service experience in industrial and consumer markets. His responsibilities have ranged from new business development to customer retention programs, organic growth objectives, LTA...
New gear skiving machine LK 300-500
Machine, tool and process from a single source

In the LK 300 and 500 gear skiving machines, process, tools and machine including tool changer and automation system come from a single source because in skiving³ the delivery of an integrated solution for the customer is of primary interest. Skiving³ is especially suited for internal gears of medium size and quantity, as it is much faster than shaping and more economical than broaching. The machine can be operated using the touch-based LHGe@rTec control system.

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- Stiffness

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- Manufacturing
- Reconditioning

**Process**
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- Implementation
- Optimization

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and pricing negotiations, and sales forecasting as well as brand identity and marketing strategies.

Before joining Jergens, Marvar held senior sales and marketing management positions representing a variety of contract manufacturers. He earned a Bachelor of Science degree in business administration and communications from John Carroll University. Marvar and his wife live in Cleveland and have two grown children.

MORE INFO www.jergensinc.com

Jenfab announces new plant manager, first quality manager

Jenfab Cleaning Solutions, a leading North American manufacturer of heavy-duty and precision cleaning aqueous parts washing systems, has announced two new additions to its staff — Mark Proffitt and Kirsten Tuter.

Proffitt is Jenfab’s new plant manager and brings with him many years of manufacturing experience.

Prior to joining Jenfab, he worked as a vice president of operations for Baker Manufacturing Company in Alexandria, Louisiana, where one of his main responsibilities was the oversight of all manufacturing for the company. In addition, he has served as a professional manufacturing consultant, plant manager, and director of manufacturing at other companies.

In addition to his manufacturing experience, Proffitt also served in the Navy as a fire control specialist aboard the Dwight D. Eisenhower and Iwo Jima.

Proffitt is a Springfield, Missouri, native and currently resides in the area with his wife and children. He has a Master of Business Administration from Columbus University and a Bachelor of Arts degree in liberal arts from the Navy Campus Program.

Also joining the company is Kirsten Tuter, Jenfab’s first quality manager. Before joining Jenfab, she was quality manager at Jarden Plastic Solutions in Springfield, Missouri. In addition, she has held positions as a stainless-steel fabricator, mechanical designer drafter, quality specialist, and senior quality specialist. Tuter’s responsibilities will include developing new processes and procedures to streamline workflow and ensure consistency throughout the company’s product lines.

MORE INFO www.jenfab.com

Heidenhain opens TNC-CNC academy for wide range of training

Heidenhain recently opened its TNC-CNC academy, an expanded CNC controls training center in the Chicago area which is available for users at all levels, including those interested in 5-axis machining. All classes are taught by Heidenhain specialists with many years of controls and CAM experience.

An expansive list of the multi-level classes is available at training.heidenhain.com. These include basic CNC training to in-depth training sessions on new Heidenhain control software upgrades, postprocessor optimization, and specialized classes for connected machining and in-process inspection, among others.

“Learn how easy it is to operate a Heidenhain TNC, or take a class to simply enhance your knowledge in order to become a more valuable employee for your company,” said Gisbert Ledvon, Heidenhain’s TNC business development manager. “Completing these classes will allow TNC users to improve efficiency and accuracy of the parts they machine by going beyond just the standard features and functions provided by a CAM postprocessor. We think users will love learning how to take full advantage of all the features and functions that the Heidenhain TNC offers as compared to other CNC controls.”

In addition, the Academy offers service classes for service teams to practice troubleshooting and repairs of Heidenhain components on real machine tools. This includes practice on a 5-axis high-precision machining center equipped with spindle speeds of up to 42,000 rpm.

Those registered are provided lunches on class days and offered discounted area accommodation options. Heidenhain also intends to expand TNC training opportunities to the West Coast in 2020.

Academy classes include basic CNC training to in-depth training sessions on new Heidenhain control software upgrades, postprocessor optimization, and specialized classes for connected machining and in-process inspection. (Courtesy: Heidenhain)
Backed by 70 years of experience, it is our mission to strengthen materials through expert-driven solutions. We are committed to delivering proven technology for a range of applications that enable you to transform space exploration, improve titanium medical implants and develop more efficient cars and jet engines.

Vacuum  Atmosphere  Customer Service  Parts  Rebuilds & Retrofits  Controls
Now located in Heidenhain’s North American headquarters in Schaumburg, Illinois, this expanded training facility includes dedicated areas called ATC and ITR. ATC is the Applied Technology Center that houses various machine tools equipped with Heidenhain TNC controls for hands-on use. ITR is the Interactive Training Room, a dedicated controls classroom with individual monitors and training materials.

MORE INFO www.heidenhain.com

EMAG receives the ‘Axia Best Managed Companies Award’

Strategic vision, capacity to innovate, sustainable management culture, and good corporate governance — the “Axia Best Managed Companies Award” sets expectations high for participating businesses. This year, the organizers from the consulting firm Deloitte, the German weekly business news magazine WirtschaftsWoche and the Federation of German Industries (BDI) have awarded the distinction to the EMAG Group. A speaker at the award ceremony said that the innovative mechanical engineering company has contributed to securing Germany’s economic future and serves as a model for others. The event took place in Düsseldorf, Germany, at the beginning of May.

Small and medium-sized enterprises (SMEs) are essential to the German economy. For instance, they generate more than half the added value and provide nearly 60 percent of all jobs, according to recent data from the German Federal Ministry of Economics. This includes many hidden champions who have advanced to become global market leaders in their industry, such as EMAG. The Group is one of the few makers of manufacturing systems that can cover the entire process chain from soft machining to hard machining. The company produces complete process chains for automotive manufacturing, as well as for the non-automotive sector. Over the past couple of decades, EMAG has succeeded in systematically expanding its expertise and tapping into new markets—an achievement that has now been recognized by the “Axia Best Managed Companies Award.”

The consulting firm Deloitte, the German weekly business news magazine WirtschaftsWoche, and the Federation of German Industries (BDI) award this quality label to exceptionally well-managed SMEs. To be considered, the award winners must first convince a panel of experts consisting of renowned representatives from business, science, and the media.

“Overall EMAG distinguishes itself by an exemplary management strategy that combines a strategic vision with the capacity to innovate, a sustainable management culture and good corporate governance. It thus conveys a model for other businesses to follow,” said Lutz Meyer, partner and head of the SME program at Deloitte.

There are a variety of examples that demonstrate what the catch phrase “capacity to innovate” means to EMAG. For instance, the company invests in the development of new production solutions that are crucial for the production of tomorrow’s products, such as electric cars, and it is also working on the digitalization of its machines with its “Industry 4.0” solutions.

“We are very pleased to receive the recognition that comes with the ‘Axia Best Managed Companies Award.’ The distinction

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ALD is a subsidiary of AMG Advanced Metallurgical Group N.V.
confirms the work we have been doing over the past few years and also is an incentive to keep making progress,” said Claus Mai, CFO for the EMAG Group. “However, this does not change our goals in any way: With our custom-fit innovations, we help our customers manufacture their products faster, more precisely, and more efficiently. This is where digitalization, for example, opens up entirely new opportunities that we will not miss.”

**Weiler Abrasives supports Workshops for Warriors®**

Weiler Abrasives, a leading provider of abrasives, power brushes, and maintenance products for surface conditioning, renewed its support of Workshops for Warriors® in 2019 with an additional $25,000 donation. The company donated $25,000 in May 2018 with the launch of the “Leading a Warriors Charge” campaign in partnership with Workshops for Warriors. The campaign continues through the end of the year.

“Leading a Warriors Charge” is a national brand awareness and fundraising campaign to help Workshops for Warriors, a nonprofit school, in its mission to provide veterans, wounded warriors, and transitioning service members with training and certifications, as well as placement into advanced manufacturing careers. Machining and welding are both key components of the school’s programs.

“We’re so excited to continue our partnership with Workshops for Warriors,” said Nate Schmid, director of marketing — Americas, Weiler Abrasives. “The work the school does not only provides those who have served in our military with the skills to pursue a viable career path, but it also offers vital support to the manufacturing industry.”

During the 2018 “Leading a Warriors Charge” campaign, Weiler helped raise awareness of its partnership with Workshops for Warriors and raised funds through advertising, video, messaging on product packaging, and signage in distributor showrooms and at special events. Special distributor promotions garnered additional donations, as did partnerships with other leading organizations in the industry. Combined with Weiler Abrasives’ original donation, the partnerships and other fundraising activities have yielded a total contribution of more than $77,000 for Workshops for Warriors.

**CRC Press offers Radzevich book on gear design**

Advances in Gear Design and Manufacture by Dr. Stephen P. Radzevich deals with gears, gear transmissions, and advanced methods of gear production. The book is focused on discussion of the latest discoveries and accomplishments in gear design and production, with chapters written by internationally recognized experts in the field. Topics are aligned to meet the requirements of the modern scientific theory of gearing, providing readers precise knowledge and recommendations on how perfect gears and gear transmissions can be designed and produced, and how they work. It explains how gears and gear transmissions can be designed to
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reach a high “power-to-weight” ratio, and how to design and produce compact, high-capacity gearboxes.

Gear experts from the United States, Germany, United Kingdom, Sweden, Bulgaria, Kazakhstan, and Israel have contributed to the book.

Among the topics that are covered:
- Fundamentals of transmission of rotary motion by means of perfect gears.
- Optimization of geometrical engagement parameters for gear honing.
- Interaction of gear teeth: Contact geometry of interacting gear and pinion teeth flanks.
- Design and generation of straight bevel gears.
- Elastohydrodynamic lubrication of conformal gears.
- Gear drive engineering.
- Adaptive gear variators – CVTs.
- Kinematic and power analysis of multi-carrier planetary change-gears through the torque method.

Powder metal gear technology.

Radzevich is a professor of Mechanical Engineering, and a Professor of Manufacturing Engineering. He received his M.Sc. in 1976, Ph.D. in 1982, and Dr. (Eng)Sc. in 1991, all in mechanical engineering. Radzevich has extensive industrial experience in gear design and manufacture. He has developed numerous software packages dealing with computer-aided design (CAD) and computer-aided machining (CAM) of precise gear finishing for a variety of industrial sponsors. His main research interest is the kinematic geometry of part surface generation, with a particular focus on precision gear design, high-power-density gear trains, torque share in multi-flow gear trains, design of special purpose gear cutting/finishing tools, and design and machine (finish) of precision gears for low-noise and noiseless transmissions of cars, and light trucks.

MORE INFO  www.crcpress.com

ANCA demonstrates soon-to-be released ToolRoom RN34 software at EASTEC

ANCA’s latest ToolRoom RN34 software release focuses on manufacturing complex tool geometries with a perfect balance. Visitors got a demo of the endmill cycles for ballnose and corner radius, tool balancing, and next generation fluting cycles at EASTEC 2019.

Thomson Mathew, software product manager, said, “With a focus on manufacturing complex cutting tool geometries for the aerospace, die mold, and power generation industry, the new features in ToolRoom 2019 will help you realize even better cutting performance and increased tool life with enhanced endmill geometries.”

Also at EASTEC was ANCA’s Management Suite, a game changer for the CNC grinding industry. Whether it is on the premise or in the cloud, it provides customers the technology to monitor the performance of their machines no matter where they are in the world. The new software also enables companies to run smart factories by providing live production information to make data-based decisions on operational improvements. Also launching soon is a new USB WiFi dongle that will add seamless connectivity to machine users.

MORE INFO  www.anca.com
Dear Membership,

My name is John Cross, I am the new chairman of the American Gear Manufacturers Association (AGMA) Board of Directors. Seeing as I am in my beginning months of serving this great association, I wanted to share how important it is — now more than ever — to get involved with AGMA.

As the president of ASI Drives, I am busy every day dealing with my business and the decisions we have to make to better serve my employees and my customers. My focus is on our bottom line and growing the company that I lead. I am able to do this because I am an AGMA member, and I am heavily involved in all they have to offer my company, my employees, and OUR industry.

While I am focused on my business, AGMA is focused on the future of gears and manufacturing as a whole. It has its finger on the pulse of everything I need to know to be a better business professional. From economic reports, emerging technology, and the latest industry news, to educational opportunities and networking events, AGMA works endlessly to supply you with the tools necessary to succeed. Serving as a global steward for gears and producing gearing standards used around the world throughout many industries, AGMA’s technical division alone is the only division that exists for the purpose of making sure our gear products are the best they can be. Everything we do starts with AGMA and because of the exceptional connections I have made there, it ends with them, too.

2019 is already a very busy year for AGMA and its members. With the new Motion + Power Technology Expo debuting in October, AGMA members will have the greatest opportunity to connect with all the moving parts of the power transmission system supply chain. This show is a great representation of how far the gear industry has come, coupled with the emerging markets that will affect the future of our business. Being an AGMA member allows me to exhibit at events like these knowing I will see a direct return on investment because they have thought of all the details to make a tradeshow attractive to my customers.

Another great reason to be a part of AGMA is that they offer the latest education for gear-industry professionals. I have personally taken classes with AGMA’s knowledgeable instructors and know how important it is to have a resource that will help me grow not only my education but also my employees’ skillsets. And now, thanks to the power and hard work of collaboration, AGMA has partnered with Richard J. Daley College of City Colleges of Chicago, to establish the first-ever AGMA National Training Center. AGMA education will thrive even more with a central location close to so many members and their employees. This type of forward thinking is why I take pride in being the AGMA chairman.

With a growing emerging technology division acting as the periscope for innovation throughout our industry, AGMA has provided members with impressive and ample opportunity to stay up to date on the latest technologies available. Through newsletters, weekly videos, factory tours, and expert speakers, the AGMA Emerging Technology Committee is comprised of some of the best minds in the industry to guide us during the transitions to our manufacturing practices that allow us to stay competitive and innovative. Manufacturing doesn’t look exactly like it used to, and it is nice to know AGMA is helping us see the future.

I really could go on about the amazing resources and opportunities that AGMA provides members. I know that many of you are busy with your work, and I can relate. I hope that, for the remainder of the 2019 year, you take a moment and participate in at least one thing AGMA is offering so you, too, can see the rewards of being a part of an association that puts its members in the driver’s seat toward success. I hope to see you all at Motion + Power Technology Expo this October; come visit me at the ASI Drives booth number 3000!

If you want to get involved with AGMA, please contact one of these departments:

- Membership: membership@agma.org.
- Education & Training: education@agma.org.
- Fall Technical Meeting: ftm@agma.org.
- Motion + Power Technology Expo: mptexpo@agma.org.
- Technical questions and standards: tech@agma.org.
- AGMA Foundation: foundation@agma.org.
Motion + Power Technology conference speakers

Motion + Power Technology Expo gathers thinkers and doers in the power transmission industry. Our conference is designed for these thinkers and doers. We are bringing you speakers who will provide you current information in two tracks: Business and Emerging Technology. Check out our speaker line-up and learn from the best at this year’s MPT Conference.

Know Your Business (business track)
- Blockchain
- Cybersecurity
- Market info
- Supply chain
- Workforce

Be Prepared for the Future (emerging technology track)
- 3D printed metal
- Electric drive technology
- IIoT
- Robotics

MPT Conference schedule
- Wednesday, October 16: 9:30 am – 4:30 pm
- Thursday, October 17: 9:30 am – 4:30 pm

Each session has a 45-minute presentation (one speaker) with an additional 15-minute Q&A portion. Presentation topics include:

Jeff Newman, VP Supply Chain Visibility Solution Sales, CalAmp
Improve In-Transit Visibility to Reduce Supply Chain Risk

Stacy Pease, Director of Customer Success, MachineMetrics
Simplifying Industrial IoT for Discrete Manufacturers

Chloe Parkins, Fluid Power Specialist, Oxford Economics
Economic Outlook and Trends Within the Industrial Fluid Power Market

John Bennett, VP and CTO, Meritor
The Future of eMobility in the Commercial Vehicle Space

Joel Neidig, CEO and Co-Founder, SIMBA Chain
The Future of Manufacturing

Kirk Rogers, PhD, Senior ADDvisorSM, The Barnes Group Advisors
Processes and New Machines for 3D Printing Metal

Tom Rouse, Founder, Rouse Contract Consultants, LLC
Effective Contract Negotiations: The Path to Commercial Success with Large OE Customers

Alberto Moel, PhD, VP Business Development, Veo Robotics
The End of Fear: How Collaborative Industrial Robots Will Change Durable Goods Manufacturing

Casey Selecman, Director – Advisory Services, IHS Markit, Powertrain Specialist
The Evolution of the Automotive Powertrain

Russ Waddell, Director, MTConnect
Standards for IIoT Interoperability

Tony Velotta, Organizational Development Leader, Scot Forge
Workforce Development using a Farm Team Approach

Jeff Hemphill, CTO, Schaeffler
Losing Teeth? The Future of Gear Trains in the Age of Electrification

James McQuiggan, CISSP, Chapter President, (ISC)2 Central Florida Chapter
Cybersecurity Hygiene in Motion

Jeff Grabowski, PhD, Materials Specialist, QuesTek Innovations, LLC
Materials Challenges and Solutions in Additive Manufacturing

Todd Palmer, Founder and President, Diversified Industrial Staffing
Hire Like Nobody’s Business

John Tuohy, Executive Director Global Solutions, and Curt Christensen, FANUC Robotics
Shopfloor Connectivity and IIoT
**Education Events**

**DETAILED GEAR DESIGN**
AUGUST 20-22, 2019 | CLEARWATER BEACH, FLORIDA
Learn how to improve gear designs and gain new insight into concepts presented through illustrations and demonstrations. Explore all factors that go into good gear design from life cycle, load, torque, tooth, optimization, and evaluating consequences.

**BASIC TRAINING FOR GEAR MANUFACTURING**
SEPTEMBER 9-13, 2019 | CHICAGO, ILLINOIS
Learn the fundamentals of gear manufacturing in this hands-on course. Gain an understanding of gearing and nomenclature, principles of inspection, gear-manufacturing methods, and hobbing and shaping. Using manual machines, develop a deeper breadth of perspective and understanding of the process and physics of making a gear as well as the ability to apply this knowledge in working with CNC equipment commonly in use.

This course is 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 interrelation and coordinated motion operating within gear pairs and multi-gear trains. Basic gear system design process and gear measurement and inspection techniques will also 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 will also be covered.

**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.
Calendario de Eventos

¿Quieres buscar educación técnica, oportunidades de red, o la posibilidad de que tu voz se escuche en el proceso de estándares, AGMA tiene algo para ofrecerte. Si deseas más información sobre cualquiera de los siguientes eventos, visita www.agma.org o envíanos un correo electrónico a events@agma.org.

**Nuevo**

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How to set up a vibratory bowl for gear finishing

Open or tight roll patterns, bowl motions, rolling speed, and alignment angles are among possible adjustments to get optimal mass motion.

This is the first in a multi-part series on vibratory processing of gears. This article is focused on machine set-up for optimal mass motion.

OVERVIEW OF THE VIBRATORY BOWL

The vibratory bowl is toroidal-shaped, consisting of a center hub surrounded by an OD wall. Direct drive machines have a motor and driveshaft set inside the center hub. Indirect drive machines have an externally mounted motor and V-belts to turn the driveshaft inside the center hub. When operating, the bowl moves up and down on springs peripherally mounted to its base. The motion, combined with the rotational inertia of the motor, generates two planes of mass motion: vertical roll and horizontal slide. Combined, the two generate a helical mass pathway.

SETTING UP THE VIBE BOWL FOR OPTIMUM GEAR-FINISHING PERFORMANCE

Amplitude is a commonly cited tool for gauging the correct machine action and it is a measure of the expansion and compression on the bowl’s springs. It is measured with an amplitude sticker mounted to the side of the O.D. wall. A higher amplitude means the springs have greater expansion and compression.

Place a part in the vibe bowl and, using a stopwatch, note the motion path and time in seconds required for it to make one lap around the bowl channel. For example, if a part rolls eight times per minute as it completes one lap around the channel, it will have traveled a further distance compared to a part that rolled just four times per one lap in the same minute of time. In the former scenario, the machine is said to have a tighter roll pattern as opposed to the latter scenario, in which the machine has a more open roll pattern.

The farther the distance the part travels to complete one lap, the more media contact the part receives, and the more refinement work that is being done. Optimally, it is desirable to maximize part rolls per lap within the physical constraints afforded by the part’s volumetric dimensions.

KNOWING THE DIFFERENCE OF CHOICE BETWEEN AN OPEN OR TIGHT ROLL PATTERN

Let’s use as an example two gear processing scenarios, both gears heat-treated and ground. In the first, the goal is to process a three-inch diameter spur gear with a flank length of one inch. In the second, the part is a three-inch diameter by 18-inch long sun shaft. In these examples, we are not interested in DP and tooth count, just the generic morphological part forms and the volumetric displacement of each part.

Since the bowl’s center hub has a smaller diameter than its OD wall, the helical spiral of motion will be tightest at the center hub. Consequently, parts are closer to one another as they plunge downward at the center hub. Each section of bowl channel, as determined visually by one part roll, is pie-wedged in shape, tighter adjacent to the center hub.

Since the three-inch diameter spur gear is more compact than the elongated sun shaft, it is more favorably finished using the tighter, eight rolls per minute lap pattern. If run with the same roll pattern, the elongated sun shaft will knot with its channel partners, like a child’s pick-up sticks, since there is a tighter pie-wedge pattern at the center hub. This greatly increases the propensity for part-on-part damage. Inversely, the elongated sun shaft would be favored to run with a more open, fewer rolls per minute lap pattern. Perhaps just one or two rolls per lap.

HOW TO ADJUST BOWL MOTION PATTERNS AND ROLLING SPEED

As mentioned previously, the bowl’s driveshaft has weight segments mounted to its top and bottom. This is common to all vibe bowls. Different manufacturers have different styles, shapes, and sizes of weights, but rest assured, all machines have them. By adding weights to the bottom of the shaft, you increase bowl amplitude. Removing weights from the bottom does the opposite, decreasing bowl amplitude. Adding weights to the top yields a more open spiral pattern, favoring the 18-inch long sun shaft. Removing weights from the top generates a tighter spiral pattern, favoring the three-
inch diameter spur gear.

Alternatively, the alignment angles between the top and bottom of the driveshaft are critical to controlling the mass rolling speed. These normal settings and steps should always be followed:

When starting the machine, be certain the motor is rotating in the correct direction. Compare motor rotation with the directional arrow decal on the bottom hatch cover. If the motor is rotating in the wrong direction, reverse the hot and neutral leads to the motor to change polarity and reverse motor rotation.

Assuring correct motor rotation, the media mass must move in the opposite direction. Sir Isaac Newton taught us all that every action has an equal and opposite reaction. As the motor rotates correctly, its media naturally moves in the opposite direction. If both the media and the motor are rotating in the same direction, then the motor is reversed. Change motor polarity as described earlier.

Make certain that the bottom weights lead the top weights into the motor rotation direction.

Always set up the machine with the bottom weight leading the top weight at a 90° angle.

**CHANGING TOP TO BOTTOM WEIGHT ALIGNMENT ANGLES**

Should you decide to change alignment angles from the typical 90° alignment angle, most bowls are equipped with a thumbscrew and 360° gauge at the bottom of the drive shaft. Loosen the set pin, then turn the thumbscrew to generate a more acute or more obtuse angle. Then tighten the set pin.

A more acute angle concentrates the top and bottom weight segments to one side of the drive shaft, making it more imbalanced. This speeds up rolling speed. A more obtuse angle balances out the weight segments on the drive shaft, producing a slower rolling speed. A slower rolling speed means the part will move forward a farther distance between rolls, thereby automatically creating a more open spiral pattern.

---

**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.
Standards in terminology for bevel gearing

Knowing the proper terminology is key for understanding bevel gear design.

If you still are digesting the acronyms in my April 2019 column, I apologize. As mentioned in that article, without a proper understanding of the terminology, you are at a great disadvantage. In the previous article, I detailed the proper terminology for spur gearing. This article hopefully will broaden your knowledge of bevel gear terminology.

The fundamental term in metric gearing is the designation of pitch. This is the pitch apex to Crown (X). This value is critical when adjusting the gear for backlash. It is calculated as:

\[ X_1 = (R \times \cos \alpha_1) \times (h_{a1} \times \sin \delta) \]
\[ X_2 = (R \times \cos \alpha_2) \times (h_{a2} \times \sin \delta) \]

The axial face width (Xb) is calculated as:

\[ Xb_1 = (b \times \cos \delta) \times (h_{a1} \times \sin \alpha) \]
\[ Xb_2 = (b \times \cos \delta) \times (h_{a2} \times \sin \alpha) \]

The addendum angle (Qa) is calculated as:

\[ Q_{a1} = \tan^{-1} \left( \frac{h_{a1}}{R} \right) \]
\[ Q_{a2} = \tan^{-1} \left( \frac{h_{a2}}{R} \right) \]

The dedendum angle (Qf) is defined as:

\[ d_{a1} = \frac{Q_{a1}}{\cos \delta} \]
\[ d_{a2} = \frac{Q_{a2}}{\cos \delta} \]

These terms and their associated values represent the geometry of the gear teeth (Figure 3). Independent of these are the geometry of the rest of the gear body. These include the bore, the hub diameter (d), the hub width, the face width (b), the length through the bore, the keyway width, and the keyway depth.

The bore is the hole into which the motor shaft is inserted. For some gears, the gear is already mounted on a shaft and thus the need to specify the bore does not exist.

The hub diameter is the outermost diameter of the boss that projects out of one or more sides of the gear. It usually functions as a shoulder to which the bearings are matched to. Its relative, the hub projection, is the distance from which this diameter projects from the heel face of the gear.

The face width (b) is the distance across the gear teeth in the direction perpendicular to the reference diameter. The face width of a bevel gear is not a set value. It is recommended that the value be at a minimum 10 + m, and R/3 as a maximum value.

The length through the bore (LTB) is the total length of the gear from the hub projection face to the opposite side of the bore. It is not the total height of the bevel gear from the tooth tip to the hub projection.

The keyway width is the value of the horizontal portion if the slot is in the bore. The distance that this slot projects out of the bore, toward the root diameter, is the keyway depth. Not all gears are produced with a key slot, so these dimensions are not always present.

Bevel gears have unique names for different portions of the gear tooth. The toe

#### Table: Calculation Formulas

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<td>X</td>
<td>((R \times \cos \alpha) \times (h_{a} \times \sin \delta))</td>
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<tr>
<td>Qa</td>
<td>(\tan^{-1} \left( \frac{h_{a}}{R} \right))</td>
</tr>
<tr>
<td>Qf</td>
<td>(\frac{Q_{a}}{\cos \delta})</td>
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**Figure 1: The reference cone angle of a bevel gear.**

**Figure 2: The meshing of bevel gears.**

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**Figure 1:** The reference cone angle of a bevel gear.  
**Figure 2:** The meshing of bevel gears.
is the portion of the tooth that is nearest to the bore. The heel is the portion of the tooth that exists at the outermost diameter. The tooth height at the toe is always smaller than the tooth height at the heel. The tooth height dimensions are always measured at the heel.

These terms apply to all bevel gears, but there are additional terms that apply when the gear set is produced as a spiral bevel gear set. These gears have a curved tooth that is set at a specific spiral angle.

This angle is most commonly set to 35 degrees. For spiral bevel gears, one gear will have teeth with a left-hand spiral, and the mating gear will have teeth with a right-hand spiral. The choice of which gear has the left-hand spiral is dependent only on the orientation of your bearings and the rotation direction of the motor shaft. As most applications are bi-directional, there is no preferred standard. Stock gearing usually has left-handed pinions and right-handed bevel gears.

Hopefully, armed with this knowledge, you will be better able to communicate your bevel gear requirements with your gear supplier, and you won’t have to worry about being lost in the weeds.

Figure 3: Dimensions and angles of bevel gears.

Bevel gears have unique names for different portions of the gear tooth. The toe is the portion of the tooth that is nearest to the bore. The heel is the portion of the tooth that exists at the outermost diameter.

ABOUT THE AUTHOR

Brian Dengel is general manager of KHK-USA, which is based in Mineola, New York. Go online to www.khkgears.us
Back to basics: The mechanism of quenching

Hot components are cooled down during contact with the liquid quenchant, normally through three stages.

Regardless of the product, it is likely that it is heat-treated and quenched. Engine components are heat-treated for wear and durability (Figure 1). Aircraft components are heat-treated for strength and fracture toughness. Even bicycle frames are heat-treated for strength, lightness, and durability. To meet these needs, it is necessary to expand the knowledge of heat-treating and quenching to consistently produce a quality product, capable of being manufactured in a cost-effective manner.

In metallurgy, the definition of quenching is “the controlled extraction of heat.” The most important word in this definition is “controlled.” The quenchant is any medium that extracts heat from the part. The quenchant can be a liquid, solid, or gas.

Each quenchant, whether it is oil, water, aqueous solutions of polymer and water, or water-salt solutions, exhibits similar quenching characteristics. These basic characteristics need to be properly understood to fully master quenching.

PHASES OF QUENCHING

When a hot component comes in contact with the liquid quenchant, there are normally three stages of quenching. There are exceptions to this, which will be explained as we cover each stage. The three stages of quenching are:

- Vapor stage (stage A or vapor blanket stage).
- Boiling stage (stage B or nucleate boiling stage).
- Convection stage (stage C).

VAPOR STAGE

The vapor stage is encountered when the hot surface of the heated component first comes in contact with the liquid quenchant. The component becomes surrounded with a blanket of vapor.

In this stage, heat transfer is very slow, and occurs primarily by radiation through the vapor blanket. Some conduction also occurs through the vapor phase. This blanket is very stable and its removal can only be enhanced by agitation or speed improving additives. This stage is responsible for many of the surface soft spots encountered in quenching. High-pressure sprays and strong agitation eliminate this stage. If they are allowed to persist, undesirable micro-constituents can form.

BOILING STAGE

The second stage encountered in quenching is the boiling stage. This is where the vapor stage starts to collapse and all liquid in contact with the component surface erupts into boiling bubbles. This is the fastest stage of quenching. The high-heat extraction rates are due to carrying away heat from the hot surface and transferring it further into the liquid quenchant, which allows cooled liquid to replace it at the surface. In many quenchants, additives have been added to enhance the maximum cooling rates obtained by a given fluid. The boiling stage stops when the temperature of the component’s surface reaches a temperature below the boiling point of the liquid. For many distortion prone components, high boiling temperature oils or liquid salts are used if the media is fast enough to harden the steel, but both of these quenchants see relatively little use in induction hardening.

CONVECTION STAGE

The final stage of quenching is the convection stage. This occurs when the component has reached a point below that of the quenchant’s boiling temperature. Heat is removed by convection and is controlled by the quenchant’s specific heat and thermal conductivity, and the temperature differential between the component’s temperature and that of the quenchant. The convection stage is usually the slowest of the 3 stages. Typically, it is this stage where most distortion occurs.

Figure 2 shows the three stages of quenching. The three phases of quenching occur sequentially at one loca-
tion. However, different locations will initiate the different phases at different times, depending on agitation and geometry of the part.

In general, at the initiation of quenching, the part is surround-
ed by a stable vapor phase. As the part slowly cools, it reaches the Leidenfrost temperature. The Leidenfrost temperature is dependent on many things such as agitation, surface roughness, surface tension of the fluid, and the hydrostatic pressure (depth of the part). It is difficult to predict. This temperature can also be changed by the presence of sharp edges, geometry, and the additive package.

Once at the Leidenfrost temperature, nucleate boiling begins. This often initiates at sharp corners or abrupt changes in geometry. In simple cylinders quenched vertically, nucleate boiling initiates at the corners of the cylinder at the upper and lower surfaces. The nucleate wave front then travels down the part from the top, and up the surface from the bottom, eventually converging.

As the part surface is cooled to approximately the boiling tem-
perature of the quenchant, the convection phase begins. This is illus-
trated in Figure 3 where high-speed photography was used to capture the three phases of quenching as they occurred on a smooth steel cylinder quenched from 850°C.

It can be observed that the three phases of quenching can occur simultaneously on the part, and the part can have widely different surface temperatures as a result. One source of distortion is thermal gradients, so it is necessary to reduce these thermal gradients, usually by adequate agitation.

Obtaining properties and low distortion is usually a balancing act. Often, optimal properties are obtained at the expense of high residual stresses or high distortion. Low distortion or residual stresses are usually obtained at a sacrifice in properties. Therefore, the optimum quench rate is one where properties are just met. This usually provides the minimum distortion.

CONCLUSIONS

In this brief article, we discussed the basics of the mechanism of quenching. In subsequent articles, we will discuss methods for measuring and quantifying the mechanism of quenching.

Should you have any questions on this article, please email the author.

Figure 3. Illustration of the sequence of quenching showing the three phases of quenching as it appears along the length of a steel cylinder.
LEAN HEAT TREATMENT FOR DISTORTION CONTROL
Proper control of heat treat distortion is of key importance to reduce production costs in gear manufacturing.

By Dr. VOLKER HEUER and DAVID BOLTON

Controlling distortion is of key importance during the case hardening process for the production of gear components. By effective control of distortion and the variation of distortion, significant costs in post-heat treatment machining processes can be avoided. In some cases, it is even possible to eliminate all post-machining operations. In other cases, it may be possible to avoid the pres- quenching of individual components, resulting in huge cost-benefits.

New vacuum furnace designs allow the treatment of small batches in a single layer of parts (“2D-treatment”), which allows for easy automated loading and unloading of the fixture-trays. By using the smallbatch concept, a continuous flow of parts can be established (“One Piece Flow”). There is no need to wait until enough parts are collected to build a large batch with multiple layers (“3D-treatment”). This compact furnace unit can be implemented into the heart of the production chain and provides heat-treatment processes that can be fully synchronized with the green- and hard-machining operations.

When performing case hardening, the components are Low Pressure Carburized (LPC) at high temperatures followed by gas quenching. The treatment in single layers offers an optimum in quality regarding:
- Temperature homogeneity.
- Quench homogeneity.
- Distortion control.

The paper shows new results of distortion control from several studies on different gear components. In addition, latest results of distortion control from serial gear production is presented.

1. INTRODUCTION

With the introduction of E-mobility, proper distortion control has become even more important than in previous days. Distorted gear components cause noise in the transmission. Especially battery-operated electric vehicles (BEVs) and all other electrified vehicles (including hybrids) will require a low noise transmission with high precision components.

Distortion has a strong cost-impact, since distorted components need to be hard-machined after heat treatment.

Better control of distortion means:
- Less cycle time per part in hard-machining.
- Less hard-machining capacity needed.
- Less tooling cost for hard machining.

For some applications, hard machining can be completely eliminated with an excellent control of distortion.

The paper shows how distortion control is improved when applying lean and tailored Low Pressure Carburizing (LPC) – processes.

2. DISTORTION MECHANISMS AND HIGH PRESSURE GAS QUENCHING (HPGQ)

The relevant mechanisms that cause distortion of components during heat treatment have been described extensively in literature [3]. Three different types of stress in the material contribute to distortion: residual stresses, thermal stresses and transformation stresses [7].

These stresses are influenced by part-geometry, steel-grade, casting, forging, machining, etc. and they depend on the heat treatment. If the total stress in the component exceeds the yield stress, then distortion of the component takes place. Walton [14] published the numerous potential factors that are influencing distortion in more detail, see Figure 1.

By applying the technology of Low Pressure Carburizing (LPC) and High Pressure Gas Quenching (HPGQ), heat-treat distortion can be significantly reduced. LPC is a case hardening process that is performed in a pressure of only a few millibars using acetylene as the carbon source in most cases. During HPGQ, the load is quenched using an inert gas stream instead of a liquid quenching media. Usually, nitrogen
or helium are used as quench gas [4,8,10].

HPGQ offers a tremendous potential to reduce heat-treat distortion. Conventional quenching technologies such as oil- or polymer-quenching exhibit inhomogeneous cooling conditions. Three different mechanisms occur during conventional liquid quenching: film-boiling, bubble-boiling, and convection. Resulting from these three mechanisms, the distribution of the local heat-transfer coefficients on the surface of the component is very inhomogeneous. These inhomogeneous cooling conditions cause tremendous thermal and transformation stresses in the component and subsequently distortion. During HPGQ, only convection takes place, which results in much more homogenous cooling-conditions [5,7,13].

Significant reductions of distortion by substituting oil-quench with HPGQ have been published [1]. Another advantage of HPGQ is the possibility to adjust the quench intensity exactly to the needed severity by choosing quench pressure and quench velocity. Typical quench pressures range from 2 bars to 20 bars. The gas velocity is controlled by a frequency converter. Typical gas velocities range from 2 m/s to 20 m/s depending on the part geometry and the steel grade of the component. Figure 2 shows a typical industrial system for the HPGQ process. The batches for such systems consist of several layers of production parts resulting in so called “3D-treatment.”

3. LEAN HEAT TREATMENT

Today’s production philosophy for gear components usually relies on the traditional separation between soft machining, heat treatment and hard machining. Heat treatment is performed in a central hardening shop. There is no continuous flow of production parts between the different operations such as soft machining, heat treatment, shot peening, and hard machining. Instead the parts are collected into batches and then moved from operation to operation. So, large numbers of production parts are stored in buffers or are in transit between the different operations.

In order to establish a more effective and economic production of gear components, the goal is to move away from batch type logistics and move toward a “One Piece Flow” of production, see Figure 3. The goal is to move single parts from operation to operation instead of moving batches of parts. This One Piece Flow production system (OPF) would realize a continuous flow of production parts and would avoid huge efforts for storage and transportation of parts between operations [2,12]. If such a total integration of all operations can be established, then this will offer new possibilities for automation, which again leads to a reduction of costs. Additionally, a higher level of automation will result in a reduction of defects in quality.

Figure 4 shows a new synchronized heat-treatment module for “One Piece Flow” production which was recently established in industrial production. This heat-treatment module allows for total integration into the manufacturing line creating a synchronized production flow with gear machining.

 Following the philosophy of “One Piece Flow” the parts are:

- Taken one-by-one from the soft machining unit.
- Heat-treated in time with the cycle time of soft machining.

Figure 2: High Pressure Gas Quenching (HPGQ) chamber of a heat treatment system for 3D-treatment.

Figure 3: Gear manufacturing with central hardening shop and with “One Piece Flow” integrated manufacturing lines.

Figure 4: Heat treat system for 2D-treatment; schematic view into the system.

Figure 5: Batch of Final Drive Ring gears for 2D-treatment (a coupon-sample was placed in the center of the batch for metallurgical analysis).
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- Passed down one-by-one to the hard machining unit.

Although the parts are not treated individually but treated in trays, the parts are individually loaded to the heat-treat unit and individually unloaded from it. So the continuous flow of single parts is established.

In comparison to treatment of big batches in multiple layers (3D-treatment), the single layer treatment (2D-treatment) provides:
- Homogenous and rapid heating of the components.
- Homogenous and rapid carburizing of the components.
- Homogenous and precisely controlled gas quenching.

All the variations from layer to layer are eliminated, which leads to reductions in distortion-variation within the load. The concept and the technology of “One Piece Flow” heat treatment have been published earlier in more detail by the authors [6,7].

4. DISTORTION STUDIES – COMPARISON BETWEEN 3D-TREATMENT AND 2D-TREATMENT

4.1 FINAL DRIVE RING GEARS
Final Drive Ring gears from a 6-speed automatic transmission are being produced since 2006 by applying LPC and HPGQ. The parts are treated in big batches with multiple layers (3D-treatment). A distortion study was initiated to quantify the possible improvement in distortion-control when switching from 3D-treatment to 2D-treatment. The Final Drive rings gears have an outer diameter of 226 mm, a height of 32 mm, a weight of 4.2 kg, 59 external teeth, and are made 4121M-material. The case hardening depth CHD after heat treat is specified as 0.7...1.1 mm, core hardness as >28 HRC and surface hardness is specified as 64...69 HR45N.

Before the distortion data was collected, it was made sure that the metallurgical quality in terms of hardness profile, microstructure and core hardness was identical for both treatments. In this study, the geometrical change during heat treatment was compared between today’s multiple layer production process (3D-treatment) at 965°C and the new single layer process (2D-treatment) at 995°C, see Figure 5.

Figure 6 shows the change of flatness during heat treatment. With 3D-treatment the average change is 55 microns and with 2D-treatment, the change is 42 microns, which means a reduction by 24 percent.

Figure 7 shows the change of roundness during heat treatment. With 3D-treatment the average change is 42 microns, and with 2D-treatment, the change is 21 microns, which means a reduction by 50 percent.

Summing up, despite the fact that carburizing with 2D-treatment was performed at 995°C and with 3D-treatment was performed at 965°C, the control of distortion was significantly improved with 2D-treatment.

When changing production from 3D-treatment to 2D-treatment, this will result in huge cost savings for the subsequent grinding process-step.

4.2 REACTION INTERNAL GEARS

4.2.1 REACTION INTERNAL GEARS TYPE A
In an earlier study, the improvement in distortion-control was quantified when switching from 3D- to 2D-treatment for a Reaction Internal gear [7,9]. This Reaction Internal gear from a 6-speed automatic transmission has an outer diameter of 167 mm, 98 internal teeth, and is made of 5130 material, see Figure 8. The case hardening depth CHD after heat treat is specified as 0.3...0.6 mm, and surface hardness is specified as 79...83 HRA.

Figure 9 shows the load set-up for 3D-treatment and 2D-treatment. All measurements were performed with a CNC analytical gear-checker. Four teeth were inspected for each gear, and both left flank and right flank were examined per tooth.
In this study, it was shown that the standard deviation of helix angle variation Vbf for the left flank was reduced by 30 percent down to 7 microns when switching from 3D- to 2D-treatment. For the right flank, the average of helix angle variation was reduced by 30 percent, and the standard deviation of Vbf was reduced by 45 percent, see Figure 10. The lower amount of helix angle variation of the parts from single layer treatment indicates that they are flatter after heat treatment compared to the ones from multiple layer treatment.

When comparing the single layer treatment at 900°C with 1,050°C, no increase in Vbf was observed. This is certainly remarkable. A standard 5130 steel grade without microalloying for grain size control was used for all tests. Although significant grain growth was detected after treatment at 1,050°C, this did not lead to increased distortion.

4.2.2 REACTION INTERNAL GEARS TYPE B

A second type of Reaction Internal gears was studied. Again, the improvement in distortion control was quantified when switching from 3D to 2D-treatment. This “Reaction Internal gear Type B” has an outer diameter of 152 mm, 103 internal teeth, and is made of 5130 material. The case hardening depth after heat treat is specified as 0.3...0.5 mm, core hardness as > 25 HRC, and surface hardness is specified as 64...69 HR45N.

Before the distortion-data was collected, it was made sure that the metallurgical quality in terms of hardness profile, microstructure, and core hardness was identical for both treatments. In this study, the geometrical change during heat treatment was compared between today’s multiple layer production process (3D-treatment) at 900°C and the new single layer process (2D-treatment) at 980°C. For 3D-treatment, 192 parts are treated in one load, and for 2D-treatment, 8 parts are treated in one load. See Figure 11.

In this distortion study, 181 parts from 3D-treatment were measured and 160 parts from 2D-treatment (taken from 20 furnace-runs) were measured with a CNC analytical gear-checker. Figure 12 shows the change of circularity during heat treatment. With 3D-treatment, the average change is 19 microns, and with 2D-treatment, the average change is 7 microns, which means a reduction by 63 percent.

Figure 13 shows the circularity after heat treatment, which means the absolute values after heat treatment. With 3D-treatment, the average circularity is 48 microns, and with 2D-treatment, the change is 32 microns, which means a reduction by 33 percent. When changing production from 3D-treatment to 2D-treatment, this improvement in control of distortion will result in significant cost savings for the subsequent grinding process-step.

4.3 INPUT SHAFTS

The distortion of input shafts was analyzed after 2D-treatment, see Figure 14. The Input shaft is made of 16MnCr5 material, has a mass of ca. 0.7kg and is treated with a load-size of 30 shafts per tray. The case hardening depth CHD after heat treat is specified as 0.5...0.8 mm, surface hardness is specified as 690...790HV and core hardness is specified as 340...480HV.

Two main parameters were analyzed for distortion: axial runout and concentricity. Figure 15 shows the positions for the measurements. The carburizing temperature was varied from 960°C to 1,050°C. Two different ways of part orientation in the CFC-fixture were tested: “hanging” and “standing,” see Figure 16. Figure 17 shows the concentricity of the shafts for different test conditions.

However, for the application of these components, the axial run-
When changing production from 3D-treatment to 2D-treatment, the improvement in control of distortion will result in significant cost savings for the subsequent grinding process step.

Figure 12: Change of circularity during LPC-treatment of “Reaction Internal gear Type B”; comparison between 3D-treatment and 2D-treatment.

Figure 13: Circularity of “Reaction Internal ring gear Type B” after LPC-heat treatment (absolute values after HT); comparison between 3D-treatment and 2D-treatment.

Figure 14: Input shaft made of 16MnCr (ca. 0.7kg per shaft).

Figure 15: Positions for measurement of axial runout and concentricity on the Input shaft.

Figure 16: Part orientation of the Input shafts during treatment: “hanging” (left) and “standing” (right).

Figure 17: Concentricity of input shafts after LPC-process under different test conditions in 2D-treatment.
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out is more important than the concentricity.

Figure 18 shows the values for maximum axial runout after treatment, the average change of axial runout, and the standard deviation of the change of axial runout. Clearly the part orientation “standing” leads to much better results. When loading the shafts “standing” into the tray, the specification of axial runout after heat treatment (40 microns) was met successfully for all three analyzed carb. temperatures.

4.4 SMALL PLANETARY GEARS AND SLIDING SLEEVES FOR HEAVY TRUCK TRANSMISSION

In an earlier study, Schueler et. al. analyzed the distortion of small planetary gears and sliding sleeves for heavy truck transmissions [11]. All parts were made of ZF7B-material, which is a modified 20MnCr5. Figure 19 shows the components.

For the small planetary gears, conventional atmospheric gas carburizing with oil quenching was compared with Low Pressure Carburizing (LPC) with High Pressure Gas Quenching (HPGQ) applying a 2D-treatment.

For sliding sleeves, conventional atmospheric gas carburizing with press quenching was compared with LPC with HPGQ applying a 2D-treatment.

For the planetary gears, significant less scattering of distortion was observed for the HPGQ with 2D-treatment compared to the conventional process, see Figure 20.

These results are very stable even after carburizing at 1,050°C and were confirmed by two additional batches with same heat-treatment parameters, see Figure 20 right.

Sliding sleeves are distortion critical parts. Therefore, they are often case hardened and press quenched as a standard process.

In the study from Schueler et. al., at first sliding sleeves made of cold formed blanks were analyzed. The measured distortion after HPGQ was huge with large scattering of the results. This can be explained by the high amount of residual stress after cold forming. When press quenching, the geometry is forced into the wanted shape despite the high amount of residual stress.

In a second study, the blanks for the sliding sleeves were hot formed with a later F/P-annealing before soft machining, which reduces the residual stress from prior steps to a minimum. With these blanks, the observed level of distortion after HPGQ with 2D-treatment was equal to the level obtained from press quenching, see Figure 21.

Therefore, producing sliding sleeves with the 2D-treatment concept that fit the requirement might be possible if the dimensions of soft machining are adjusted with respect to the distortion behavior after heat treatment [11].

5. SUMMARY

Proper control of heat-treat distortion is of key importance to reduce production costs in gear manufacturing.

The technology of Low Pressure Carburizing (LPC) combined with High Pressure Gas Quenching (HPGQ) offers the potential to reduce the amount of distortion compared to conventional case-hardening technologies. The amount of distortion can be further reduced when switching from multiple layer LPC-treatment (3D-treatment) to single layer LPC-treatment (2D-treatment).

This was demonstrated in several studies on transmission compo-
ments. For a Final Drive Ring gear from a 6-speed automatic transmission, the average change of flatness during heat treatment was reduced by 24 percent when changing from 3D-treatment to 2D-treatment. The average change of roundness was reduced by 50 percent. This improvement in distortion control will result in significant cost savings for subsequent hard turning and grinding process steps.

Further practical examples for improved distortion control on internal gears, Input shafts, sliding sleeves, and other transmission components are given in this paper when applying tailored LPC-processes with 2D-treatment.

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IS ANYONE PRINTING GEARHS USING METAL ADDITIVE MANUFACTURING?
After months of investigation, AGMA’s Emerging Technology Committee has found that additive manufacturing, particularly 3D printing, has the potential to provide many opportunities for gear manufacturers.

By MARY ELLEN DORAN

The AGMA Emerging Technology Committee wanted to look at additive manufacturing through the lens of the goal of the committee: “Identify, investigate, and inform AGMA members of Emerging Technologies that may disrupt or significantly impact the gear manufacturing industry.”

We started out with one question: Is anyone printing gears using metal additive manufacturing?

Our goal was to seek answers and report back to the AGMA community. Eight months later, we are here to report that not only have we seen — and touched — a variety of printed gears from several distinct metal additive manufacturing processes, but we also have gathered enough information to publish a paper on the topic, provide answers to members’ questions during a webinar, and provide a high-level, hands-on tour of metal 3D technology for members.

For those who are not aware, AGMA has been doing work in emerging technology for the last two years. In October 2018, the Association created five unique subcommittees in the areas of 3D metal printing, electric drive technology, Industrial Internet of Things (IoT), new materials, and robotics & automation. Each committee has a chair and participants who come from within AGMA member companies. Additionally, we have sought out experts to provide information to committee members.

Right from the start, the 3D Printing Committee and the New Materials Committee combined forces to tackle the subject of additively manufactured gears. Our 3D Chairman, Justin Michaud, CEO of REM Surface Engineering, had done work with some companies in this space and started to do research on the machines and processes. Bill Bennet, a metallurgist with Ellwood National Forge, began work into the materials side of additive. We reached out with questions to a known expert in the field, Kirk Rogers PhD. Rogers is a materials scientist who has done extensive work in additive manufacturing with GE and is now a consultant at The Barnes Group Advisors. He became a technical adviser to the group and eventually became the lead author of the AGMA paper, Additive Manufacturing Technologies for Gears, available free to AGMA members through the store on the website.

THE PAPER

The paper provides a high-level overview of the Additive Market and descriptions of the seven types of additive manufacturing processes as defined by the American Society of Testing Materials (ASTM), Committee F-42. It then goes into a discussion of this technology specific to gear manufacturing.

Here are some of the high-level points that the committee would like to share:

- Because of similar drivers in other industries, production of metal AM systems and materials sold into AM have been growing at greater than 20 percent compound annual rate since 2014.
- While AM systems were invented more than 30 years ago, they were primarily thought to be used to customize our environment. This technology is also well-known for the ability to reduce the price of complex components, to reduce the number of assembly parts in high-level assemblies, and to provide next generation performance by enabling complex designs. It has only been in recent years that these processes are being looked at and developed as a mass production technology.
- From a materials perspective, metal AM has been dominated by titanium alloys, nickel and cobalt-based superalloys, and stainless steels. Lack of familiar gear steels is one of the factors that has limited the adoption of AM in the power transmission industry. But some of the steels normally used for gear making are available, and more materials are being brought to market every day.
- There is an increase in the number of vendors producing metal AM machines. In 2010, there were seven companies. Now, there are more than 25. Specific for gear manufacturers, the most important point of the paper is that production of Grade 2-requirement gears by additive manufacturing is a reality for prototyping and low-volume applications, and several newer machine manufacturers hold promise to manufacture near net shape gear blanks with high productivity and lower cost than was possible only two years ago.
- But it is important to stress the point that the process of additive right now does not mean that a manufacturer can just print gears and be finished. All AM processes that were reviewed by the committee produce parts that require some sort of post-processing, including thermal process. A typical surface roughness on “good” additive processes is roughly 200 to 500 Ra. One example is laser powder bed machines, which produce approximately five miles of welds per cubic inch of material. The end piece will need thermal treatment that is either a stress release or normalizing treatment to develop the microstructure that gives the mechani-
General properties wanted. The surface finish in AM processes can be compared to a casting surface, and for gears, it would require heat treat and other surface treatment finishing.

Additive manufacturing provides many opportunities for gear manufacturers. Probably the biggest opportunity is complex geometries. Designers can start to think about things they have always wanted to be able to do but have been hindered by conventional manufacturing processes. Additive provides the opportunity to introduce internal cooling or lubrication channels that allow you to put the lubrication in the exact position that would be most beneficial to the heavy-load application. Additive can also help reduce gear system inertia through new designs that are difficult to manufacture conventionally. Designers can improve the durability through the use of multiple optimized materials in a single part. And AM can be used to reduce product-development time and time-to-market.

Probably the most obvious opportunities for gear manufacturers right away are to use AM technology to design and print customized aids, tools, jigs, and other solutions in-house to reduce current development times.

THE WEBINAR
During our metal 3D printing member webinar on May 1, more than 25 questions were fielded by Dr. Rogers by the more than 60 attendees. He provided information on the largest size gears that can be made using laser-powder fusion. On most machines, it is 9.5 inches square; however, the largest machines available have 500mm x 800mm build platforms, so there is the possibility for something in the realm of 15 to 17 inches in diameter. He described the accuracy for laser sintered parts is plus-or-minus about 0.1mm, but that it does vary by application and system. And he provided specifics on machine and materials manufacturers.

Dr. Rogers was asked his thoughts on the future of AM in gear manufacturing. The question specifically asked for a 10-year projection. He was quick to answer that in 10 years he would “expect some very high-end industrial applications being run-of-the-mill, normal, almost boring because it is done by two or three different manufacturers.” You can access the full webinar through the AGMA website.

THE TOUR
The final piece of the AGMA 3D Printing Emerging Technology Trifecta was a 3D metal printing tour on the floor of the RAPID/TCT Show on May 23. AGMA set-up formal meet-and-greets with 13 companies that spanned the depth and breadth of both machine makers and material developers. The tour included stops at:
- 3DEO
- Desktop Metal
- EOS North America
- GE Additive
- GEFERTEC GmbH
- GKN Powder Metallurgy
- HP
- Markforged

Specific for gear manufacturers, the most important point is that production of Grade 2-requirement gears by additive manufacturing is a reality for prototyping and low-volume applications.
Included on the tour were three AGMA members with distinctly different products.

In mid-April, Mitsubishi Heavy Industries announced the commercialization of a metal 3D printer. The company’s machine, called LAMDA, uses directed energy deposition (DED) technology. Advanced features include inert gas shielding and process monitoring for quality control and documentation. Blended product materials provide increased design flexibility. Applications range from aerospace, automotive, and energy sectors, as well as repair of parts and near net shape parts of Ti alloy.

Committee member Jeff Grabowski was on hand to provide members information on QuesTek and its development of materials for additive. QuesTek is a global leader in integrated computational materials engineering and designs and develops new high-performance alloys for specific customer applications. It is also well known in the industry as the designer of Ferrium® C64® gear steel, licensed to Carpenter Technology and is being qualified for next generation aerospace transmission applications. C64 steel is one of the few carburizable steels that have been successfully atomized and processed via AM. (Figure 1)

And Chairman Justin Michaud discussed the work of REM Surface Engineering in the field of AM. REM is known for its isotropic super-finishing technology, which provides finishes that can increase efficiency and wear resistance as well as bending fatigue resistance in AM applications. Each of the three companies were so vastly different in their placement in the additive field that they were a nice inclusion to the more traditional names in machines and materials developers as well as some newcomers to the industry.

We had 30 individuals from AGMA member companies who attended the tour. The attendees spanned the industry with individuals from machine tool companies, materials development organizations, steel producers, and gear manufacturers. In the post-survey tour, there were two questions that had interesting results for the committee: 73 percent of attendees considered themselves as intermediate in their knowledge of the additive industry. And when asking their reason for attending, nearly 27 percent answered “my company has been looking to invest in this technology.” So, it is not surprising that 20 percent of attendees answered “likely” or “very likely” when asked if they would invest in this technology in the next 12 months.

In the coming months, the committees plan to continue to monitor the development of materials that can be used to print gears. We will work with our members to get more examples of 3D printing gears, as available, and we will watch as the machine technology that has been designed for mass production in additive expands its use in the marketplace to see the future possibilities for the mass production of gears using this technology.
A LEADER ON HIGH-QUALITY INSTALLATIONS

Epicyclic gear assembly of Artec design.
(Courtesy: Artec Machine)
For nearly 50 years, Artec Machine Systems has been trusted for engineering design, parts, field repair, and maintenance of all types of heavy gear systems.

By KENNETH CARTER, Gear Solutions editor

Gears are essential parts to the workings of countless machines, but when those machines are dependent on specifically designed gears, then service and repair can become a special niche.

For Artec Machine, servicing equipment furnished with specially engineered gearing is at the very heart of what the company does.

“We consider ourselves a leader on high quality installations,” said John Amendola, CEO of Artec Machine. “We only work on engineered products. We don’t get involved much with commodity type gears. Gears that you can select out of a catalog, that’s not our business.”

AFTERMARKET REPAIR
Artec executes aftermarket-oriented repairs based on problem installations, as well as maintenance on existing installations, according to Amendola.

“We perform field maintenance; we do troubleshooting in the field; we do rebuilds, and we do redesigns,” he said. “We do some new installations, but I’d say with new applications, we’re sort of developing that as we go. This is relatively limited for us. Most of our business is aftermarket.”

Artec rebuilds gearboxes and conducts in house tests on them and, if required, in accordance with API 613. Artec also has installed a high-speed balancing machine and magnetic particle inspection booth. Gears that come into Artec are completely cleaned, overhauled, tested, painted, and shipped as new units.

Artec also offers field services including periodic maintenance inspections, condition reporting and analysis, onsite overhauls and gearbox repairs — including bearing/rotating equipment replacement — vibration analysis/diagnostics, and failure analysis. Other services include gear failure prevention, gear repair analysis, new gearbox installation/commissioning, specification review, and design upgrades.

SERVING A RANGE OF INDUSTRIES
Artec participates in several different — and disparate — industries, including oil & gas, ski, cement, food, and wire. Their “uniqueness” is often what drives customers to the experts at Artec, according to Amendola.

“Our business is engineered products, and that’s why we’re a participant in the energy industry and the ski industry, because those gears are really technically designed around the service that they’re in,” he said. “And there are no two sites that are exactly alike. So, most of these applications are unique to that particular site.”

Gears at different locations may be similar in size and frame, but the ratios may be different or the powers may be slightly different, for example, according to Amendola.

“You certainly can see that in oil & gas such as in upstream installations there are no two sites alike,” he said. “The ski industry is the same way. You have two ski resorts where the locations are totally physically different. The loads are different because the environment is different. So, the gears are tailored for that particular site.”

In 2014, during an energy project for a floating platform owned by an oil company, Artec worked with the company with 72,000 HP machines that were struggling with tooth-contact failures, according to Dereck Yatzook, manager of Contract Engineering at Artec.

“There were two units on one FPSO (floating production storage and offloading) platform — 72,000 horsepower each, pitch line velocity of 145 meters per second,” he said. “We designed the toothing corrections and contracted the manufacturing of the new rotor sets and performed the commissioning to make sure that the customer had optimal tooth contact, and those have been running for many, many years now.”

Part of Artec’s approach to a customer’s challenge...
is its commitment to the job, according to Amendola. "When we go on job sites, we do complete tear downs," he said. "If it's a major overhaul, or, if it's practical, it would be moved to our shop."

**TEMPERATURE, NOISE, VIBRATION**

Artec approaches a challenge by looking at several areas that may indicate a problem: obvious changes in vibration, temperature, and noise, according to Amendola.

“These three criteria — temperature, noise, and vibration — are three physical signs of something happening," he said. "Lubricant sampling and analysis is another important parameter. We try to get as much information as possible about a site beforehand.”

The next step after evaluating the situation is to determine a customer’s circumstances and if it can tolerate any downtime, according to Amendola.

“The ski industry, for example, has seasonal breaks; the energy industry doesn’t," he said. "They're more apt to have us go on site. The ski industry is mixed. They get downtime, so they can afford to send the gear here and live with the lead time necessary to get things overhauled. So, there are different demands based on the industry.”

**THE IMPORTANCE OF EDUCATION**

Artec not only is committed to giving the best quality of workmanship to its customers, but Yatzook added another key commitment is Artec’s dedication to education.

“We want our customers to be informed about their installations,” he said. “We host a lot of maintenance seminars. We're doing it for AGMA. We'll be hosting a maintenance seminar in the fall at the Motion + Power Technology Expo (formerly Gear Expo).”

At AGMA’s Fall Technical Meeting, Artec will be presenting a paper, and Amendola said that, for the ski industry, Artec hosts a maintenance class for almost every exhibition it attends.

“We are very engaged in AGMA,” he said. “Our team shares activity in a number of committees that write the standards.”

In 2011, Artec presented a paper at FTM on material transformation in high-speed gears, according to Amendola.

“I think we're the first ones to have put that experience in writing," he said. "We discovered it entirely on our own through field inspections and came to find out that there was some written history by Darle Dudley that identified the problem but did not elaborate on it. There was no real experience where it actually impacted on the installations in the field. We found that; we reported that, and we wrote a paper on it.”

**DIVERSIFYING ITS EXPERTISE**

Amendola attributes Artec’s diverse portfolio to demands that are constantly shifting. When the company first began in 1972, it was heavily focused on energy, so much so that at one time it was 90 percent of Artec’s business. In the 1990s, Artec entered the cement industry, and that became a dominant part of the company’s work flow. But as that market ebbed more than a decade ago, Artec needed to look elsewhere to maintain business and apply its accumulated technology. Through a partnering relationship with Kissling AG in Switzerland, Artec entered the ski industry, as well as the food industry.
Both afford a stable business environment.

“If you take, for example, the ski industry; we’re in it, and yet, we see more opportunity there,” he said. “There is still room to grow, and it’s fairly steady. The food industry is another market for Artec. Artec has obtained a contract with a major food manufacturer. Artec maintains four spare co-rotating extruder drives supporting 17 global installations. When they have a facility down somewhere or they’re planning on shutting it down, we’ll ship the spare to that site, and they’ll ship the damaged gear back to us. We repair that, and then that becomes the spare.”

Artec’s ability to repair such a unique machine is part of the company’s special expertise, according to Amendola.

“It’s special, and we’ve learned how to disassemble and assemble those gears,” he said. “There’s a technique to it. You just can’t put a mechanic on it. He’s got to understand the timing of those elements in order for that gear to be assembled properly. That’s something that we’ve learned how to do. We had our fits learning the first couple of them. I mean we finally got it, but it would take us weeks to get it right. But now we understand how to do it, and we can do the assembly in one or two days. There’s a lot of in-house technique and technology here that we’ve developed working with these engineered-type gears.”

With its diverse portfolio of industries that it serves, Amendola expects Artec to keep expanding in those areas.

“I believe we’ll continue to grow in ski,” he said, “and we’ll stay with cement in a modest way. We definitely will continue to grow in food. It’s just the tip of the iceberg. That’s a steady market. At the same time, Artec will remain in the energy market. That’s where our name is known and it is in the cutting edge of gear technology. If there is new equipment coming up somewhere, we’re a known entity that encourages people to come to us.”

MORE INFO
www.artec-machine.com
The ZE26C will respond to needs for higher speed and precision, especially in the transmission systems of electric vehicles and the reduction gears used in robots. (Courtesy: Mitsubishi Heavy Industries Machine Tool Co.)

Mitsubishi to show ZE26C gear grinding machine at Motion + Power Expo

Mitsubishi Heavy Industries Machine Tool Co., Ltd. (MAT) will follow the world debut of the ZE26C at CIMT in China with the 2019 Power + Motion Expo in Detroit on October 15-17.

The ZE26C will respond to needs for higher speed and precision, especially in the transmission systems of electric vehicles and the reduction gears used in robots. This will be the first time the ZE26C will be exhibited in North America.

By suppressing the gear tooth shape error measurement to 1μm, the transmission units and gear reducer units (where the gears are used) performance is enhanced and quieter operation is achieved.

The ZE26C was developed to finish hardened and tempered gears with outer diameters up to 260mm. Superior performance has been achieved by making improvements to the ZE-B series of widely acclaimed gear grinding machines. Specifically, the ZE26C’s grinding precision and stability have been enhanced by increasing the rigidity of the column, table and grinding wheel head, coupled with revamping of the spindle structure. In addition, by increasing cutting speed and reducing idle (non-cutting) time by roughly 50 percent compared to earlier models, the ZE26C boosts high-volume production capability and promotes lower running costs.

Furthermore, by expanding the maximum wheel width to 160mm, frequency of wheel replacement is reduced and simultaneous mounting of standard and polishing grinding wheels is simplified, enabling response to a variety of in-factory needs and higher operational performance. Also, adoption of the industry’s first water-soluble coolant (optional) improves environmental performance while also enhancing energy savings.

At Motion + Power Expo, the new ZE26C will perform a gear grinding demonstration (dry run). A demonstration will also be given of MAT’s “DIASCOPE” monitoring system, which uses IoT technology to give visibility of real-time production status.

The demand for more precise gear finishing and mass production of precision gears is rising amid the shift to electric vehicles, enhancements in noise and fuel performance, and moves toward low-cost production. In addition, most recently demand is expanding for robot reduction gears as development of versatile robots gather momentum. The new ZE-C series has been launched to respond to this growing trend of gear grinding machines requiring ever higher speed and precision.

Going forward, MAT, in its position as the manufacturer of gear cutting machines holding the No. 1 spot in the Japanese market and a pioneer in gear cutting and manufacturing technologies, will dedicate its resources to providing innovative technologies and systems for gear cutting and manufacture.

Mitsubishi Heavy Industries Machine Tool Co., Ltd. (MAT) is a Group company of Mitsubishi Heavy Industries, Ltd. (MHI) based in Ritto, Shiga Prefecture in Japan.

MORE INFO www.mhi-machinetool.com/en

FX7 Linear is ideal for regrinding, light manufacturing

ANCA’s investment in research and development has paid off with its own AR300 robot loader that has been designed by its talented engineers to offer customers a cost-effective automation option.
For customers who require increased flexibility or more spindle power, or the increased automation capacity that a robot can provide, the FX7 Linear offers these. The FX7 Linear offers a wide range of options for those looking to increase productivity and accuracy. The AR300 robot loader is available as an option to increase efficiency by automating repetitive manual tasks.

Features include:
- Linear motors on X and Y axes.
- AM5000 control system for faster processing.
- HSK40 taper provides increased rigidity and accuracy for improved tool surface finish results.

Demand for industrial robots is booming, as manufacturers chase productivity gains and the availability of effective, user-friendly options increases. According to the 2018 World Robotics Report, annual unit sales increased 30 percent in 2017 and have more than doubled over the last five years.

Russell Riddiford, president of ANCA Machine Tools, said, “With a large percentage of ANCA customers buying machines with robotic functionality, it’s fair to say the age of the robots has come. Far from a nice-to-have add on, many CNC machines now come with operator panels that provide in-built control over both the grinding software and the robotics function, opening the door to greater automation efficiencies. At ANCA we provide a complete solution to our customers, designing and manufacturing almost all our technology in-house. As part of this, we developed our own low-cost solution for tool loading.”

The 3-axes ANCA robot has a capacity of 380 tools and accommodates tool sizes up to Ø20mm (3/4") x 150mm (6") long. The AR300 loader is contained within the compact FX Linear machine footprint, so there is no need for extra floor space. In addition, there is no need to change gripper fingers between batches, which further maximizes productivity.

Using the latest control technology from ANCA Motion, the AR300 loader is an excellent value-for-money auto tool loading solution for the FX5 Linear and FX7 Linear two-wheel changer machines. The loader provides quick tool loading, as the tool is passed directly from the pallet to the collet in a single gripping action.

MORE INFO   www.anca.com

Buehler launches the AbrasiMet XL Pro™ cutting machine

Buehler, an ITW Company, launched the AbrasiMet XL Pro™ large abrasive cutter at Control 2019 to provide consistency and repeatability in cutting large samples for production environments.

The AbrasiMet XL Pro allows the sectioning of high-quality cut samples with a diameter up to 7 inches (178mm) which is best in class for an 18" cutter. It also has a 10kW motor, the most powerful motor on the market for this size abrasive cutter, and uses 14-inch (355mm) to 18-inch (457mm) blades.

Quality control lab technicians in the automotive, aerospace, metals, and other manufacturing will minimize processing times and ensure consistency and repeatability while enhancing the quality of cut samples with the AbrasiMet XL Pro. Its durable design, intuitive user interface, and optimized chamber will make it the ideal cutter for customers using Chop, Y-feed, or Planar cutting types.

The AbrasiMet XL Pro meets rigorous demands of high-volume quality control with these features:
- A touchscreen user interface with programmable methods reduces the time spent setting up for a cut by saving of cut parameters. This includes blade size, cutting type, serial cutting, and chamber wash-down. When processing a variety of parts, users can quickly load the specific program for their sample and begin cutting.
- Accuracy in alignment and serial sectioning. The cutter has movement tracking system to allow for precise cutting parameters and a green laser for easy X-alignment. One joystick controls all three-axis movement of the cutting arm and t-slot table which...
allows the blade to be precisely positioned. With precise X, Y, and Z movement of the blade, multiple cuts can be made with one programmed cut.

- **Save time changing blades with the self-tightening lock nut.** The only tool needed for changing a blade is your hand, eliminating the time and effort needed to find the right wrench and remove the lock nut with the added benefit of minimizing the risk of injury.
- **Easy to clean with the newly designed recirculation system that simplifies cleaning.** A secondary filtration tank with a stationary filtering screen collects swarf which users can clean without changing out any coolant. Gone are the days of struggling to clean and empty a large and hard-to-remove tank.
- **Large windows and bright LED lighting.** Allow users to observe the cutting process and quickly detect if the cutting process needs to be adjusted.

MORE INFO  www.buehler.com

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**Tormach servo motors now available for 1100M and 770M CNC mills**

Tormach Inc. is now offering servo motors for its line of 1100M and 770M CNC milling machines. Servo upgrade kits are available for current users of these machines, which allows them to transform their current ‘M’ series machines to ‘M+’.

Complete information on obtaining the user-installed servo motor upgrade kits, with video tutorials, can be found on Tormach’s website.

Users who upgrade to servo motors will see numerous benefits, including:

- **Faster speeds — more than double feed rates.**
- **Higher acceleration — allows machine to get up to speed much quicker.**
- **Reduced noise.**
- **Closing of the feedback loop into the control system.**
- **Time and money savings on every part made.**

Tormach has released a video, available on YouTube, that shows examples of the time savings that can be achieved using the servo motors over the conventional stepper motors: tinyurl.com/y6q8app5.

“For the vast majority of machinists using our 1100M and 770M mills, upgrading to the servo motors is an easy decision,” said Lori Morrison Bufalo, marketing director at Tormach. “We’ve made it easy and affordable for users to perform this upgrade and start getting even better performance out of their Tormach mills.”

The cost to upgrade to the servo motor...
MPT Expo is all about innovation. With the latest demands for efficiency and power density, often the solution is a choice combining mechanical, fluid power, electric, and hybrid technologies. Learn about the research driving the next generation of innovation at the MPT Conference, AGMA’s Fall Technical Meeting, and other education seminars. And then experience it hands-on at the exhibits, with new products and demonstrations from 250+ exhibiting companies, including start-ups in the emerging technology pavilion.

REGISTER EARLY AND SAVE! Visit MotionPowerExpo.com
Package is $1,995. Additional recommended items including an automatic oiler kit are available for an additional fee.

Later this year, Tormach plans to offer a BT30 spindle upgrade package to users as well. This upgrade will allow users to take their ‘M+’ mills to the ‘MX’ level, meaning they will have the servo motors along with BT30 spindles, encoders, and power drawbars.

MORE INFO www.tormach.com

IWIS develops products, processes to keep chains performing optimally

For a chain to have a long service life without wear-related loss of performance, it needs to be serviced and lubricated regularly.

Maintenance and lubrication intervals should be strictly adhered to: about two thirds of all chain failures can be prevented by suitable relubrication, so selecting the right (re)lubricant is the most important factor in guaranteeing a long service for the chain, since the individual links of a chain act as bearings while the constantly oscillating chain is in operation. Inadequate lubrication and additional contamination can cause a reduction of chain performance to as little as 20 percent of its full potential, thereby reducing service life more than any other influencing factors.

IWIS drive systems produce precision roller and conveyor chains for industrial applications in the field of general machine engineering, plant engineering, the packaging, printing, and food industries, and conveyor technology. In recent years, the recognized chain specialist has conducted intensive research into solutions that prolong chain service life, as well as developing its own range of lubricants. On the solid basis of countless trials, special test apparatus, and close cooperation with reputable lubricant manufacturers, IWIS is a reliable expert partner for all aspects of chain lubrication. A combination of a suitable lubricant and the appropriate lubrication process ensures a measurable reduction of wear and additional corrosion protection.

Important information on the correct use of lubricants is available from IWIS engineers and for download in the IWIS flyer “Lubrication solutions” (on the company website), which contains checklists with possible warning signs, tips on optimum lubricant dosage, preparing chains for lubrication, applying lubricants, and selecting the ideal lubrication point, and recommendations for the right lubricant – depending on the respective application and chain type used. The choice of initial lubricant is equally important and is taken into consideration accordingly. The IWIS flyer also gives maintenance staff valuable hints for their day-to-day work in a compact, well-organized form.

IWIS also offers solutions for applications that do not permit relubrication. The bushes of maintenance-free JWIS MEGAlife chains

The right relubrication for extended chain life.
(Courtesy: IWIS)
are made from sintered material, so the lubricant is retained in the chain joint long-term. Chains stay dry on the outside, but the joint is always well lubricated – and JWIS b.dry stainless steel chains require no lubricant.

MORE INFO  www.iwis.com

Big Kaiser’s new Fullcut Mill Contact Grip series offers versatility

Big Kaiser, a leader in premium high-precision tooling systems and solutions for the metalworking industries, introduces the Fullcut Mill Contact Grip, an endmill that permits easy indexing of cutter heads while maintaining excellent rigidity and accuracy. With the addition of the Fullcut Radius Mill (FRM) and the Ball End Mill (BE), the Fullcut Mill Contact Grip series now features four connection sizes and seven cutter types.

The unique dual contact grip of the Fullcut Mill Contact Grip is a threaded coupling system that achieves machining capacity close to that of integrated types. The taper and flange face make close contact for solid connection and one holder allows selection from multiple heads.

The FRM includes round inserts with high rake for low cutting resistance, making it ideal for ramping and helical milling applications. The BE is solid CrN-coated carbide for superior wear resistance and is available with two or three flutes in diameters of 16, 20, or 25 millimeters.

Indexable endmills are usually known for rough milling. However, other cutters in this series, like the Fullcut Mill FCM Type for profile milling, are designed to realize sharp cutting and low cutting resistance, thanks to the versatile dual-contact Contact Grip design. Similarly, the Fullcut Mill FCR Type heads are multifunction 3D cutters suited for both heavy and stable ramping. Also part of the series are three chamfering options, the C-Cutter Mini for transvers chamfering, the C-Cutter for plunge chamfering, and the C-Cutter Universal for adjustable angle chamfering.

MORE INFO  www.bigkaiser.com

Reliability begins with a cup of coffee.

Relationships are built by taking the time to sit down with you, and discovering what keeps you awake at night.

Colonial isn’t typical in the SPINDLE INDUSTRY: establishing customer relationships that are a perfect fit providing spindle systems to international companies looking for experience and reliability. The solutions we provide delivers the highest quality in the world at a reliable Lowest Cost Per Piece, GUARANTEED! An industry first.

What do you take in your coffee?
ANCA helps customers move toward a smart factory solution

ANCA technology is building smart factories for its customers. Businesses can reduce wasted materials and time through 3D simulation. Simulation and 3D modeling tools offer a way for businesses to measure and plan without requiring the use of materials outside the digital environment.

For example, Scripting, a simple programming language created specifically to automate tasks within ANCA application software, can be used to automate most tool design tasks, such as entering parameter values or drawing line/arc elements in 2D editors. It can also be used to create sophisticated fully-featured custom tool wizards with graphical user interfaces. This means less work for the operator, knowledge retention through capturing design and process intelligence, and reduced programming and set-up time.

Tool manufacturers are applying cloud technology — ANCA’s Management Suite/Redax — to monitor machines and production in real time, allowing better informed decisions to be made at the time when they will have the most impact ability to remotely schedule, control, and monitor networked machines so factories today can access real-time information, providing enhanced visibility and greater control over manufacturing data.

Data analytics are already a core component of many tool manufacturers’ operations. The use of advanced analytics is being applied end-to-end across the production and supply chain activity, providing valuable insights into areas including production levels, inventory, available capacity, quality levels, order status, predicting machine failures, ensuring production uptime is maximized, and more.

About 70 percent of ANCA customers buy machines with robotic functionality. CNC machines now come with operator panels that provide in-built control over both the grinding software and the robotics function, opening the door to greater automation efficiencies.

In-process measurements such as ANCA’s LaserPlus allow the measurement of tool geometries to tolerances of 2 microns or less without removing the tool from the grinder, saving time and ensuring maximum accuracy in measurement.
With 70 years of experience, we can handle all your custom workholding needs. Drewco Corporation is a family run business led by a team of engineers and machinists. We are backed by original patents, years of experience, and proven effective designs.
Get a Grip

Gleason’s new Modular Standard Workholding solution puts the exceptional changeover speed of Quik-Flex® into small, medium and large standard modules, readily available for the most common cylindrical gear bore sizes. All are equipped with ‘New Blue’ Segmented Collets for maximum reliability and wear life.

www.gleason.com/grip
One of the most vexing problems in machining today is how to most efficiently make an out-of-round part round. In the days of thick-walled tubing or cut slugs, this manufacturing task presented little difficulty, but with today’s thin walled near-net-shape parts, the difficulties mount. Fortunately, we have developed several ways to make this task much easier.

It takes three points to define a plane. This fact of geometry is why a three-legged stool or table will never tip. No matter what uneven shape the floor beneath may have, three points of leg contact will always be able to find a flat plane defined between them and therefore not tip.

In the clamp chuck shown in Figure 1, we have three clamps, and three pads on the work stop surface. No matter what geometry the part being held may have, these three locating points will always be able to conform to the part’s geometry, and thereby impart no deforming stress to the part.

The yellow detail is a retracting push-on collet, manufactured to be slightly larger than the part. It must be slightly compressed in part loading. By this light spring tension, the part is centralized and held in place while the clamps are being actuated. After the clamps actuate, the push-on collet retracts out of the way, so that the full part bore may be turned and the outer face can be machined inside of the clamps for a second operation flat locating face.

This is a custom-designed mechanism. We have many different styles of clamp and centering devices. The style of chuck can be configured to virtually any required configuration. Other common options included in this design are through the spindle coolant flush, part air confirmation circuits, and carbide or diamond coating of the clamps or work stop pads.

A second method of creating a round part from an unround one, is to coat the gripping mechanism with a compressible polymer. In this case, the yellow detail (Figure 2) is a standard Speedgrip collet, which has been coated (the red) with a 70-durometer polymer coating.

This method is often used for parts with soft highly-finished bushings, where a hardened steel collet would...
objectionably mark the bore material, or possibly when gripping powdered metal parts, which are already close to being round. The polymer can be configured in an array of hardinesses depending on the needs of the application.

The latest entry into our non-rounding arsenal is the finger collet. Having similarities both to a diaphragm chuck and a collet chuck, this mechanism is an economical alternative to a multi-jaw chuck.

The external finger collet in Figure 3 was designed for approximately a seven-inch ring gear. It has 12 gripping fingers, each one controlled by its own actuating die spring.

To start the design process, we need complete information on the part material, geometry, and maximum r.p.m. of the machining operation so that an accurate CAD model can be created, and we can run FEA studies to fully understand the part and how it behaves under the chucking forces. Of special importance, we require to know the maximum out-of-roundness that may be encountered in the part as it comes to this operation, and the required roundness and flatness of the machined surfaces.

Figure 4 is an internal gripping finger collet. The part was a 13-inch ID 4340 forging. The forging coming to the operation, was roughly 0.100 out of round. Our customer was performing several turning operations, alternating between ID and OD gripping to work the out-of-roundness out of the part.

In one machining operation, we were able to create surfaces that were less than 0.003” out of round. This chuck has 24 gripping segments. The fingers are relieved such that every other set of fingers gripped at the front and at the back of the part, thereby distributing the chucking forces over as much of the part as possible.

The latest entry into the non-rounding arsenal is the finger collet. Having similarities both to a diaphragm chuck and a collet chuck, this mechanism is an economical alternative to a multi-jaw chuck.
With this one chuck, the customer was able to eliminate two machining operations. The same issue that exists with non-rounding during machining is also an issue during the part inspection process. The same 13” 4340 casting part that we held for machining on the first operation also needed to be inspected on a gear checking inspection machine. (Figure 5)

The original process of tramming in a 4-jaw chuck for each part was very time-consuming. Speedgrip was approached for ideas on how the inspection operation could be improved. We developed a push-on collet chuck for the application.

In this case the collet was manufactured slightly smaller than the low part limit of the part OD. Gentle force was required to insert the part into the collet. The part was quickly and accurately centered, without any deformation.

Not totally confident of such a new and easy method of checking their parts, the customer had the first hundred or so parts indicated after being chucked in the push-on collet. When no misloads were discovered, the push-on collet was trusted with a very important operation. The comment was made by the customer that this was the best tooling investment that they had made in a long time.

Push-on collets come in a wide variety of configurations and with many varied options. They can be mounted between bench centers, or on a manually rotating spindle (as shown). (Figure 6)

ABOUT THE AUTHOR

David A. Stokely is the chief designer at Speedgrip Chuck in Indiana. Speedgrip Chuck’s engineering department, with almost 200 years of combined workholding experience, continues to push the boundaries of what is possible. For more information visit www.speedgrip.com.
“I don’t always buy workholding but when I do, I prefer König”

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303-776-6212
The creativity of the designers knows no bounds with new drive element and gear geometries. Faced with constantly increasing demands from a wide variety of industrial sectors, today solutions are being sought that often cause major problems in production. The trend toward special products, small and special series, prototypes, and test setups is omnipresent. But can these specific components still be manufactured economically and efficiently, without compromising the required precision and repeatability in the manufacturing process?

Previously, the production of small series had to be carried out at very high cost, which ultimately caused unit costs to explode. Until now.

For bevel gears, there is now a completely new solution on the market that will make both designers and production departments sit up and take notice. Precision grinding of small batches on the Haas Multigrind® significantly increases surface quality and component accuracy, while at the same time reducing manufacturing costs many times over.

**CIRCULAR ARC OR CYCLOID**

On the Haas Multigrind® grinding machine, almost all variants of special bevel gears can be ground extremely economically, both circular arc and cycloid geometries. And not only that, but the ground bevel gears set new standards with regard to precision and reproducible quality.

“In every industry, be it automotive, aviation, robotics, wind power, etc., there are standard requirements for series products and a growing number of specific special applications,” said Wolfram Hermle, chief developer at Haas Schleifmaschinen. “A modern high-performance transmission or differential in a production car can always be produced in series on a conventional milling machine. But not a special gearbox for a racing car. The demands on material and precision are so extraordinary that it makes sense to choose a much more suitable production route. Or let’s think of a satellite, whose awning has to be unfolded reliably after reaching the final position. The conditions in space make a second, third or fourth chance difficult. Also, in the prototype development of the robot industry, no designer wishes that expensive blanks be milled and ground until the desired result is almost perfect.”

**BEVEL GEAR: MILLING OR GRINDING?**

Grinding, of course. For special productions in small series, the use of expensive milling tools is not worthwhile. And in order to produce a perfect surface, you would have to regrind anyway. The Haas Multigrind® grinds even highly complex workpieces directly from the solid, faster, more precisely and also, considerably more economically.

**BEVEL GEAR ALL-ROUNDER + PROBLEM SOLVER = MULTIGRIND®**

In terms of flexibility, precision, and productivity, the Haas Multigrind® grinding machine series is the perfect choice for small series production of highly demanding bevel gears. With at least 5 axes and an enormous drive power in spindle and rotary axes, this production unit offers a maximum of power and dynamics. The machine’s thermostable, vibration-damped cast mineral bed provides the required stability.

**MULTIGRIND®: GEAR CUTTING AND/OR CYLINDRICAL GRINDING IN A CLOSED LOOP**

Complex workpieces such as special toothing on bevel gears can be completely machined in a single clamping, which significantly increases precision and saves a lot of unnecessary set-up time. Should, in exceptional cases, further clamping be necessary, this is done with repeat accuracy and without loss of precision.

In automated machining, the patented tool changer precisely guides the required grinding wheels of various sizes and designs to the workpiece. The grinding wheels with a size of up to 300 mm are dressed again and again during the entire grinding process, i.e. brought back to their correct geometric shape. The desired quality can only be achieved with all gearings by exact form dressing in a closed loop.

**HOW NEW CUSTOMER REQUIREMENTS PUSH THE BOUNDARIES OF WHAT IS FEASIBLE**

Hermle knows what relevance this new standard will
have in bevel-gear production in the various industries.

“With our customer-centric approach, Haas Schleifmaschinen is part of the solution for many design engineers and workpiece manufacturers,” he said. “We are often asked when the limits of what is feasible should once again shift in favor of more precision, economy, and complex special shapes. The fact that a Multigrind® grinding machine, i.e. a universal grinding machine, masters these special tasks best seems to be a contradiction for many people who are not familiar with our technology. Our customers and users know that the high degree of flexibility of our grinding technology is also based on the intelligent control by the Multigrind® Horizon software.”

THE PERFECT INTERACTION OF SOFTWARE AND HARDWARE

With the Haas Multigrind® Horizon software, the projected bevel gear is calculated according to exact path specifications and visualized three-dimensionally in a very fast and exact one-to-one simulation. In this way, the real image of the bevel gear to be produced is obtained and minimal programming errors can be resolved in advance. The automatic collision monitoring before the start of production provides additional safety. The path-optimized calculation of traverse movements saves a lot of time later in production.

The Multigrind® Horizon software enables control instructions and machine data such as measured values, sensor data, control variables, and parameters to be configured, controlled, and operated from the tablet. The complex mathematical design data can be described by a
few parameters. The result: a user-friendly user interface with an intuitive operating concept. There is no need to spend a lot of time setting up the system individually with “fingertip sensitivity.”

Orders are allocated automatically, either via the RFID codes of the raw parts and comparison with the ERP system or from the online shop. Haas Schleifmaschinen has implemented the integration of production and measuring technology in the closed loop in a practical manner both with its own software and in the Multigrind® grinding machine. Thus, the Multigrind® Horizon software is optimally designed for the production environment of Industry 4.0, a consistent step toward digitization in bevel gear production.

COMPACT INFORMATION

Bevel gear grinding on the Multigrind® CA offers maximum flexibility and precision with short throughput times thanks to gear and cylindrical grinding in a single operation, as well as low tool costs and minimum set-up effort. It is suitable for circular arc or cycloid geometries. The production of bevel gears from 10 mm to 150 mm takes place in a closed loop. It is ideally suited for small series for batch sizes of 1 to 100. It’s also suitable for special products, prototypes, and test setups, and is ideal as a useful supplement to the large series production of bevel gears on standard milling machines.

When it comes to shifting the limits of what is possible by a few microns, Haas Schleifmaschinen is the place to go for designers and production specialists. “We like to make things complicated,” says Managing Director Dirk Wember. “Haas Schleifmaschinen relies on tradition that goes back 80 years. Our niche strategy, our thirst for research, and our consistent customer focus form the basis of our success. We meet every complex new grinding requirement, even if it does not seem feasible at first glance. The inventors at Haas Schleifmaschinen thus perfect their products and market them globally. The sophisticated Multigrind® high-end machines are a model of German engineering artistry and grind all over Europe, North America, China, and Japan. Many different industries already rely on the advantages of the Multigrind® series: highest precision, maximum flexibility, and high efficiency.”

The Multigrind® grinding machines are developed and produced in the Black Forest. But only in combination with the Multigrind® Horizon software is the full potential fully exploited.

“The topics of the future — digitization, automation, and cloud applications — are no longer a vision for Haas Schleifmaschinen,” Wember said. “We are already working on the suitability of these future topics for everyday use and today already offer customer-specific solutions that have proven their worth.”
We have all heard the phrase WORK SMARTER, NOT HARDER. Makes sense, right? In times of economic uncertainty, it's SMART to maximize the efficiency of every one of your resources. Workholding technology that allows you to go from O.D. to I.D. to 3-jaw clamping in a matter of seconds without readjustment can maximize the production—and the profits—of your existing machines. Now that is WORKING SMARTER.

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A SUCCESS STORY: LOW-DEFORMATION WORKPIECE CLAMPING

Before an optimum clamping solution can be defined, many requirements of the workpieces, type, machine frequency, and process-change integration must be properly addressed.

By Steve Hartung

Those who want to turn, mill, or grind rings, flanges, housings, or other thin-walled parts will quickly reach the limits of what is possible using conventional lathe chucks or face plates: The parts are deformed during the clamping process; shaping and geometric tolerances are difficult to keep to, and the interfering contours of the clamping devices restrict the accessibility. There are great deal of alternatives here—from the compensating multi-jaw chucks, the magnetic clamping technology, right up to the pendulum jaws. In order to ensure that things run smoothly, it is worth knowing the strengths of the individual problem solvers, because this saves time, money, and often nerves.

As is so often the case for low-deformation workpiece clamping, there is no one-size-fits-all solution. The requirements of the workpieces, type, and frequency of the machining as well as the integration into the process change vary so severely that an individual observation at the user level is always worthwhile. The following questions are primarily important here:

- What parts are to be machined in what batch sizes?
- How flexible must the machine be able to be used?
- What shape and position tolerances must be adhered to?
- How will the parts spectrum develop in the future?

Only when these and other aspects have been clarified the optimum clamping solution can be defined.

PENDULUM JAWS MULTIPLY THE NUMBER OF CONTACT POINTS

For pendulum jaws, users take advantage of the number of clamping points in order to minimize deformations on the workpiece. This way, with identical clamping force and a doubling of the clamping points, the achievable roundness accuracy increases in practice by a factor of 10. Usually, pendulum jaws are made of a movable mounted pendulum body with two clamping inserts, which are mounted on a supporting jaw with the aid of a bearing bolt. For demanding applications, there may be four or six clamping inserts, either soft or case-hardened. As pendulum jaws are mounted like one-piece top jaws, a conventional 3-jaw chuck can be converted into a 6-point clamping in no time. As the jaws are adjusted to the workpiece, they can compensate for form tolerances within a certain range, for instance, with cast bodies.

It is beneficial if such pendulum jaws can be fixed for finish machining or for clamping pre-turned surfaces. Furthermore, the jaws should be as light as possible so
as to achieve faster speeds. Calculation programs can be used for calculating what compensation is required for achieving specified concentricity tolerances. Primarily for small tolerances, experience pays off, because with matured special solutions, enormous effects can be attained. But there are also restrictions: Pendulum jaws are comparably expensive; they wear out easily, and they are sometimes quite heavy and restricted when it comes to flexibility.

COMPENSATION JAW WITH CENTRIFUGAL FORCE AND VIBRATION COMPENSATION
Hydraulic compensation jaws set a new benchmark for low-deformation workpiece clamping. They combine a balancing workpiece clamping with centrifugal force compensation, vibration-damping characteristics and micron-precise concentricity. The integrated oil chamber system is a central feature, above which two or more oscillating clamping elements for clamping rough or finished parts are mounted. As they individually adapt to the workpiece, form tolerances of cast bodies, for example, are reliably compensated. Compared to conventional 3-point clamping, the number of clamping points is increased, which also lowers the deformation of the workpiece and the obtainable roundness is significantly increased.

At high speeds, the hydraulic clamping system automatically ensures centrifugal force compensation so the clamping force is always reliably maintained. In order to minimize workpiece deformation, the clamping force can be considerably reduced in comparison with previous solutions without restrictions on process reliability. For maximum precision on the component, the concentricity also can be adjusted micron-precisely on the chuck jaws. Additionally, the vibration-damping characteristics of the oil-chamber system result in a better surface quality of the workpiece and the tool life. Hydraulic compensation jaws are suitable for low-deformation OD clamping of rough and finished parts and are available for all lathe chuck sizes and serration types.

COMPOSITE JAWS ARE THE MOST COST-EFFECTIVE ALTERNATIVE
Special jaws made of fiberglass composite are an often underestimated problem solver. Their high coefficient of friction of 0.3 to 0.4, as well as a large angle of wrap ensure that high machining forces can be transmitted even with low clamping forces. Here, the support structure of the aluminum supporting jaw ensures stability. As a result of the low weight, only low jaw centrifugal forces are created during turning operations. As a result, plastic jaws are also suitable for high machining speeds up to 6,000 rpm. In addition, they do not leave
Magnetic chucks with electrically activated permanent magnets are a real set-up time killer for low-deformation workpiece clamping. These are used in different versions for low-deformation workpiece clamping. The most common are radial pole plates for which the magnetic elements are arranged radially around the center. With them, bearing rings, for instance, can be machined in a single set-up on the outer and inner diameter and on the front side. As the magnetic field acts into the outermost peripheral zone, even large workpieces are clamped securely and without any deformations. Due to the two-dimensional holding force, the machining takes place largely without any vibrations. This protects the cutting edges of the tools and improves the quality of the workpiece surface. To align the workpieces, the holding force can be adjusted using the control system or the holding force regulation. In order to ensure optimum stability, radial pole plates up to a diameter of 4,000 mm should be produced from a single piece. For larger plate diameters, plates in segmental design may be advantageous as these can be transported more easily. To suit the respective application, there are standardized radial pole plates in three versions: for grinding operations, as an AlNiCo single magnet system; for turning operations, as an AlNiCo double magnet system with high holding forces; and finally, for demanding volume machining with milling and turning as an extra strong AlNiCo neodymium magnet system.

**OSCILLATING MOUNTED 6-JAW CHUCK ENSURES HIGH REPEAT ACCURACY**

The smaller the tolerances on the workpiece, the higher the required repeat accuracy; the more speaks in favor of oscillating balancing 6-jaw chucks. They consist of a central chuck piston carrying three inner pendulums aligned at 120 degrees. Each pendulum is connected to two base jaws. This ensures workpiece centering between six contact points, which can be adjusted in pairs. As the clamping forces are directed towards the chuck center, optimal centering is achieved without distortion of the workpiece even for raw parts.

Workpieces are aligned and clamped in the 6-jaw chucks in no time. The chucks are perfectly adapted to the raw part with their oscillating jaws. For finish machining or for clamping pre-turned surfaces, the pendulums can be clamped similar to the pendulum jaws in the center positions, meaning all six jaws can move concentrically. Because of its high precision, it is possible to eliminate entire production steps, for example, by reaching tolerances during the finishing process that would otherwise only be reached in complex grinding operations.

**RADIAL POLE TECHNOLOGY FOR INTERFERING CONTOUR-FREE MACHINING**

Magnetic chucks with electrically activated permanent magnets are a real set-up time killer for low-deformation workpiece clamping. These are used in different versions for low-deformation workpiece clamping. The most common are radial pole plates for which the magnetic elements are arranged radially around the center. With them, bearing rings, for instance, can be machined in a single set-up on the outer and inner diameter and on the front side. As the magnetic field acts into the outermost peripheral zone, even large workpieces are clamped securely and without any deformations. Due to the two-dimensional holding force, the machining takes place largely without any vibrations. This protects the cutting edges of the tools and improves the quality of the workpiece surface. To align the workpieces, the holding force can be adjusted using the control system or the holding force regulation. In order to ensure optimum stability, radial pole plates up to a diameter of 4,000 mm should be produced from a single piece. For larger plate diameters, plates in segmental design may be advantageous as these can be transported more easily. To suit the respective application, there are standardized radial pole plates in three versions: for grinding operations, as an AlNiCo single magnet system; for turning operations, as an AlNiCo double magnet system with high holding forces; and finally, for demanding volume machining with milling and turning as an extra strong AlNiCo neodymium magnet system.

**SQUARE POLE TECHNOLOGY INCREASES FLEXIBILITY**

Users wishing to act flexibly on mill/turn centers combine magnetic chucks with square pole technology with an efficient pair: They use the magnetic chucks both on top for clamping workpieces and downward for flexibly placing the clamping solution on the machine table. Such a solution can be set up and loaded with a workpiece in just a few minutes. Here, variable pole extensions ensure a safe and, at the same time, deformation-free workpiece clamping.

Without additional set-up effort, workpieces of varying sizes can be machined alternately with a high level of precision on the quadratic pole plates from three or five sides. With the aid of a multi-level holding force control system, the parts can be aligned within seconds and clamped without any deformations by means of a short current pulse. Like with the radial pole plates, no additional energy feeding is required for square pole technology after having activated the permanent mag...
net. Compared to conventional clamping solutions, the set-up time is reduced by 30 to 80 percent.

HYBRID CHUCKS COMBINE RADIAL POLE TECHNOLOGY AND A CENTERING CHUCK

The peaks of the low-deformation workpiece clamping are formed by hybrid chucks, for which the technology of a classic 3- or 6-jaw centering chuck is combined with the technology of a radial pole plate. The clamping process is designed extremely easily: The workpiece can be manually inserted into the chuck, which will be centered by three chuck jaws, and then securely clamped by electropermanent magnets.

Particularly for large rings, it is worthwhile that vibrations are eliminated, which has an effect both on the workpiece quality and the tool costs. The parts are simply pre-roughed. Then the magnet is temporarily deactivated in order to release workpiece warping, and then the part can be finish turned. The hybrid chucks can also be activated at varying power levels. They are suitable for use on revolving lathes, mill/turn machines, vertical pick-up lathes and special machines.

ABOUT THE AUTHOR

Steve Hartung is rotating workholding group manager. He has worked for SCHUNK for 18 years, where he manages the rotating workholding team in the U.S.

Hydraulic compensation jaws combine a high precision, low deformation workpiece clamping with vibration damping characteristics. Even at high speeds, the clamping force is fully maintained. (Courtesy: SCHUNK)
Heule Precision Tools presents BSF tooling for spot facing

Heule Precision Tools presents its BSF tooling for automated high-volume back spot facing applications. The BSF tool, ideal for counterbores up to 2.3x diameter and ranging in size from 6.5mm to 20.5mm (0.256" to 0.807"), is sold standard-stock, shipped the next day from the Cincinnati, Ohio, warehouse.

This tooling works without an anti-rotation device, change of spindle direction, or any machine adaptations, allowing components to be spot-faced in the same direction as the bore is drilled. This saves the time and cost of turning the workpiece, while allowing the spot facing of difficult to reach areas like yoke forks, screw-head countersinks, and more. The blade expands using centrifugal force when activating the spindle, and retracts from coolant pressure, which moves a piston to depress a pin which retracts the closed blade into the housing. The simple swing mechanism combined with the internal coolant pressure system yields optimal cutting performance, resulting in consistent spot facing and fewer scrapped parts.

The tool works both vertically and horizontally, with replaceable carbide-coated blades for extended tool life. It is ideal for countersinks, engine casings, and other parts in a wide range of materials.

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

MORE INFO www.heuletool.com

Weiler Abrasives introduces CrossFlex™ honing brushes

Cross hole deburring and honing solutions for offhand and automated applications

Weiler Abrasives, a leading provider of abrasives, power brushes and maintenance products for surface conditioning, has introduced its new line of CrossFlex honing brushes designed to provide machinists with performance and value for their professional honing applications. Available in small, medium, and large diameters and with heavy-duty options, these brushes provide a surface finish free of metal burrs and are ideal for manual or automated use in automotive; marine, oil, and gas production; aerospace; and tube, pump, and valve production applications.

CrossFlex brushes are designed to provide a long operational life, lowering the total cost of use compared to other brush options. They are available in a variety of grits to achieve the desired finish, along with offering increased brush-to-part contact to remove even the heaviest burrs compared to nylon tube brushes. Flexible nylon stems distribute pressure evenly, self-centering within the part to create an accurate hone. Available collet-ready brushes deliver a true center rotation and exceptional brush balance for both hand-held and automated applications. CrossFlex brushes also feature a consistent cross hatch pattern to ensure proper seating of piston rings and to retain oil for lubrication in combustion cylinders.

Understanding that not all finishing and deburring applications require a standard solution, Weiler Abrasives offers the option to work with one of its Weiler Process Solutions specialists to create custom CrossFlex brushes. Solutions include custom-sized brushes for specific bore diameters, brushes with longer or shorter stems, and brushes that are collet-ready or require another connection method. CrossFlex brushes can also be customized with the desired abrasive: silicon carbide, aluminum oxide, zirconia alumina, or ceramic grains.

For honing applications, Weiler Abrasives recommends using honing oil with its CrossFlex brushes for engine cylinders and hydraulic oil for hydraulic applications. In deburring applications, the brushes are compatible with water-soluble and -synthetic coolants.

MORE INFO weilerabrasives.com
New Seco threading grade excels in critical parts and materials

To prevent threading chips from ruining critical parts in the final phases of production, the advanced coating and tool geometry of the new TTP2050 threading insert grade from Seco Tools combine to provide efficient, secure, stable performance, along with effective chip control.

The TTP2050 grade’s nano-laminate PVD coating increases tool life on inserts and produces high running parameters for increased threading productivity, giving it the extreme wear resistance to machine cast irons, tool steels, stainless steels, and other challenging steels. Made from alternating layers of titanium aluminum nitride (TiAlN) and titanium silicon nitride (TiSiN), this chemistry outperforms the general-purpose coatings often used on threading tools. At the same time, the TTP2050 grade offers the tool geometry to increase productivity in these challenging materials. The TTP2050 threading grade is available in 44 profiles with geometry-A, in 11 mm and 16 mm (0.433” and 0.650”) sizes. The grade comes in internal and external threading for all standard, common thread profiles.

MORE INFO  www.secotools.com

JMPP optimizes tool life and tooling-cost containment

Automotive industry manufacturers have basic requirements from their suppliers — they want on-time delivery, accuracy, and sufficient available stock. They want perfect parts, but they want them to be immediately available at a price they can control.

Tooling is a vital and often overlooked process in the production of automobiles, as every single part of a new car requires a unique tool. What if an invisible problem inherent to CNC manufacturing existed, robbing manufacturers of the ability to produce parts accurately, and interfering with the production rates and cost containment? The automotive manufacturing community is working to answer these challenging tooling cost containment questions and find progressive solutions therein.

A few years ago, Boeing contacted one of its tooling manufacturers, Briney Tooling Systems, a leading supplier of CNC tool holders and shrink-fit tooling systems in North America, reporting they had performed testing that revealed a flaw in the V-flange tooling they were using. Requesting a solution, Briney reached out to JM Performance Products, Inc. to get its assistance in resolving the problem Boeing described. JMPP investigated and ultimately designed a gage that mirrors the interior grind of a CNC spindle. This gage measures movement or growth of the toolholder taper down to 7.5 millionths of an inch in diameter.

JMPP identified the essential flaw, the invisible problem plaguing CNC manufacturers, as toolholder expansion. Using its gage to perform extensive testing, JMPP proved that toolholder expansion is caused by the installation of a standard retention knob into a V-Flange holder.

Briney had reported expansion of its holders with as little as 13 ft./lbs. of torque during retention knob installation. This expansion creates a bulge in the holder at the small end, causing the holder to make contact with the small end instead of the large end, effectively reversing the way the toolholder is designed to fit the spindle, allowing the holder to move randomly within the spindle. Using the taper shank...
test fixture. JMPP redesigned the knobs, finally reaching a design that eliminated or substantially eliminated toolholder expansion. Boeing’s major complaint was associated with the vibration and chatter that was causing tolerance and finish issues on extremely expensive parts. The introduction of the high-torque knobs effectively eliminated the chatter issues.

Increasingly, the automotive industry is using more carbide tools primarily because they can cut both aluminum and hard materials such as titanium, carbon, and exotic alloys at high speeds. Carbide tooling is expensive and also fragile.

Recently, Sandvik, Inc., a high-tech and global engineering group with about 42,000 employees, loaned one of its engineering representatives to test the best retention knobs for Caterpillar® with a $1,200 solid carbide tool. The specification included: a toolholder, retention knob, tightening spec, and proper placement. The test’s goal was to get the custom carbide tool to run without shattering.

When tested with JMPP’s high-torque knobs tightened to the provided torque specifications, it worked every time with no tool shatter. A carbide tip cannot vibrate when it makes contact, or it shatters. Essentially, carbide must smoothly enter into the pocket and maintain its position in the pocket or it breaks. JMPP’s high-torque knobs have been proven to extend carbide tooling life.

Ultimately, by making a simple change — moving to the high torque retention knobs — CNC manufacturers can eliminate the vast majority of issues, improve milling operations, and get the best results while saving money. This high-torque solution is so successful that JMPP guarantees the results its customers have been realizing on any V-flange toolholder that is made to the AT3 or better taper tolerances. They offer to provide high-torque retention knobs at no charge for testing purposes to any manufacturer willing to provide tracked tool life prior to and post-installation of the knobs. JMPP maintains that its high-torque retention knobs are the only tool that can deliver increased productivity and performance on virtually every V-flange tool used in CNC manufacturing.

MORE INFO  www.jmperformanceproducts.com
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‘WE MUST NEVER STAND STILL’

Metrologists take on new, frequent challenges for quality control.

From ZEISS INDUSTRIAL QUALITY SOLUTIONS

Small series and prototype production at ZF Friedrichshafen AG create new challenges for quality control time and again: measurement programs for new components need to be created every day. ZF metrologist Mehmet Akol accepts these challenges with unrelenting curiosity and uses ZEISS training courses to help him.

Whether it’s parts for a bus, train, or ship, small series and prototype production at ZF Friedrichshafen AG manufactures a wide range of driveline and chassis technology. What’s special about it? The batches have between one and 50 units, and the requirements on the individual components are high. Prototypes must be quickly executable, and functioning parts have to be sent to the customer at a moment’s notice. That’s why quality control is so vital in this line of work.

“Measurement programs are compiled centrally for series production,” said Uwe Ersing, head of Quality Control for small series and prototype production at Commercial Vehicles and Special Driveline Technology. “My staff have to compile new measurement programs on an ongoing basis, and different requirements apply to different components. Gearboxes for marine technology, for instance, are subject to the regulations of the classification societies. This results in strict specifications for documenting measurements.”

A total of 32 employees, 13 of them metrologists, are responsible for quality control. Akol is one of them. For the last seven years, he has been working in metrology and is motivated by the ever-changing requirements.

THIRST FOR KNOWLEDGE

Akol joined ZF Friedrichshafen AG 10 years ago and initially worked in gearbox production. Every day he was faced with measurement results for quality inspection. If these conflicted with the results produced by his processing center, Akol wasn’t satisfied with simple explanations.

“I always wanted to know where the measurement results came from and why they turned out the way they did,” he said. “I constantly asked about this, and that’s why I drew so much attention to my quality inspections.”

This prompted Akol to switch to metrology three years later; he’s not easily satisfied with his measurement results here, either.

“Everyone can share a result, but you have to know how it came to be and how you should evaluate it,” he said. “Only then can it be valuable for the others.”

He always questioned processes and results and wanted to find out the background to them. His curiosity led him to attend his first AUKOM seminar at ZEISS in 2014, which he followed up with AUKOM Stages 2 and 3 and AUKOM Form and Location. He also attended further seminars on CALYPSO, GEAR PRO, and on offline programming. He even received training in a special subject: the Fourier analysis.

CONSISTENT, CONTINUOUS TRAINING

Even though Akol has attended many seminars and has a folder filled with certificates, he’s by no means done. A metrologist’s thirst for knowledge seems to know no bounds.

“Standards and drawing specifications change, and software is further developed,” he said. “Time and again I see components and I wonder if they’ve been perfectly programmed.”

Ersing, who joined ZF 38 years ago, has noted a great
Metrologist Mehmet Akol, above, joined ZF Friedrichshafen AG 10 years ago and initially worked in gearbox production. “I always wanted to know where the measurement results came from and why they turned out the way they did,” he says. (Courtesy: ZEISS Industrial Metrology)

Small series and prototype production manufactures a wide range of driveline and chassis technology. (Courtesy: ZEISS Industrial Metrology)
interest for further training and development among his younger employees — and he supports them wholeheartedly.

“We must never stand still,” he said. “The demands made on our industry are changing far too quickly.”

That’s why further training has a special place in quality assurance at ZF. Every new metrologist who works on 3D coordinate measuring machines spends their first six months working on further internal training measures before completing AUKOM seminars 1 and 2. In an attempt to become more efficient and bring together metrologists from different sites and areas, ZF now holds these training sessions on site. Twice a year, AUKOM seminars for Stages 1 and 2 are in Friedrichshafen and conducted by a ZEISS instructor.

STANDARDIZATION AND COMMUNICATION

Ersing sees a great advantage to this type of further training: namely, standardizing quality inspections.

“It’s important that our measurement programs are structured in the same way,” he said. “Without such consistent training, 10 metrologists measuring the same component could provide us with different measurement results.”

The seminars offer a further benefit for quality assurance in small-series production: communication and teamwork with Production has improved dramatically as a result. If the measurement results are questioned in Production, the metrologists can explain them much better to their colleagues, and justify them, too. This has also enhanced teamwork between the two departments. It also means that metrologists are now involved in problem-solving more often in order to check where potential error sources could be.

“Components and drawings are becoming increasingly complex,” Akol said. “If a metrologist finds out that the measuring result is not OK, they will first take a close look at the result and not the component. That’s what used to happen to me, too, and it’s why good communication is so vital. I work with my colleagues from the processing center to find an optimum solution.”

That’s exactly what he loves about his job.

“I need the daily challenges associated with working in quality assurance for small-series production,” he said. “It’s always exciting to compile a measurement program for a new component. It’s important to note the special features of the component, position, and secure the component correctly on the measuring machine, and define the different parameters, such as measuring speed. This normally also has to happen to relatively tight deadlines. This limits the time we have for the measuring job and demands an optimized process for the measuring program. Then again, the more complex the job, the more fun it is.”

ABOUT THE COMPANY

ZEISS Industrial Metrology is a leading manufacturer of multidimensional metrology solutions. These include coordinate measuring machines, optical and multi-sensor systems, and metrology software for the automotive, aircraft, mechanical engineering, plastics, and medical technology industries. For more information, go to www.zeiss.com/metrology.
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Klingelnberg eases measurement of complex parts

Whether turning blanks, ground workpieces, or rolling bearings, Klingelnberg Precision Measuring Centers of G variant (the latest P 40 G, for example) are specifically designed for use in the production process of rotationally symmetrical components.

Stringent precision requirements in series production and increasing component complexity — both call for the best available measuring technology. The Precision Measuring Centers of G series are optimally matched to production processes that require not just dimensional measurement tasks but complex form and surface measurements in large numbers. This makes the P 40 G appealing for the automotive and commercial vehicle industry, for machine building and plant engineering, and for manufacturers of rolling bearings. Like all Precision Measuring Centers from Klingelnberg, the G variants stand out for their patented, high-precision 3D Nanoscan probe system as well as their easy-to-use roughness probe systems for external and internal measurements. The new hybrid measuring and testing technology, comprising tactile and optical measurement, has become an essential pillar of efficient, smart production concepts.

Klingelnberg P series Precision Measuring Centers are used throughout the world for accurate measurement of gears and high-precision, rotationally symmetrical components. They deliver reliable measuring results even in a manufacturing environment and can be implemented along the entire production chain. The G variants — the P 40 G Precision Measuring Center, for example — are the only machines in the P series to be equipped with software for dimension, form, and position measurement as standard.

Among other things, the software determines diameters and distances, and measures cylinder and cone shapes, face runout and concentricity, roundness, surface flatness, and angularity. It can also perform a Fourier analysis on rotationally symmetrical components. By capturing scanned contours at all levels of an automatic process, it also enables measurement and evaluation of complex structures. These Precision Measuring Centers of G variant are thus able to replace gauges, coordinate measuring machines, and form measuring instruments. As a result, the P 40 G performs the measurement tasks in an entire test chain, where multiple measuring machines are traditionally used.

This universal solution from Klingelnberg opens up new possibilities for rotationally symmetrical components both in terms of quality assurance and with respect to automation. The new functional diversity of the EasyStart software serves as the basis for this. The software delivers a broad range of information for quality management on the one hand while also enabling efficient process control and reliable management of production processes. After each manufacturing step, every feature can be immediately displayed graphically or in table format, analyzed, and statistically evaluated — and every measuring result can be permanently assigned to a component by means of a scanner and coding (DMC, bar code, or QR code, for example). The basic software also includes storage of statistical data for further evaluation, such as warning limit specifications.

An Industry 4.0 concept can be realized through active forwarding and processing by means of existing interfaces to Klingelnberg GearEngine®. Such solutions are a key ingredient in success, particularly in times of highly accelerated innovation cycles and increasingly stringent requirements.

MORE INFO www.klingelnberg.com

Olympus DSX1000 offers advanced tools for failure analysis, accuracy

The new DSX1000 digital microscope combines the quality of renowned Olympus optics with the ease of use of digital technologies. Designed to measure and observe a variety of materials, the microscope offers guaranteed high- and low-magnification accuracy and precision in a single instrument for users in the electronics, metal, semiconductor, automotive, aerospace, and medical device manufacturing industries.

New benefits and features enhance the DSX1000 digital microscope’s performance
and measurement capabilities, including:

- Fast, one-button switching between 17 objective lenses for low and high magnification, from 20X to 7000X.
- Telecentric optical system offers guaranteed accuracy and repeatability* at all magnifications.
- The best image function enables users to quickly compare and choose the best observation method between six options, brightfield, oblique, darkfield, MIX, polarization, and differential interference contrast.
- 60 frames-per-second image acquisition means fast, smooth image stitching for large samples.
- The memory function saves user data for quick, easy setup, and repeatable image acquisition.

Users can change lenses by pushing a button and quickly go from macro-scale inspections to micro-level observations. High numerical aperture lenses provide high resolution at high magnification, so users can see the fine details in their samples. When working with larger samples, such as electronic boards or machined components, super long working distance objectives minimize the chance of accidentally damaging a sample during analysis, while the coded free-angle observation system and rotating stage (±90°) make it easier to inspect samples from many angles.

*To guarantee XY accuracy, the calibration must be completed by an Olympus service technician.

New benefits and features enhance the DSX1000 digital microscope’s performance and measurement capabilities. (Courtesy: Olympus)

More Info

www.olympus-ims.com

Measurement professionals to meet at CMSC 2019

The Coordinate Metrology Society® (CMS) will host a slate of 21 original, expert-authored white papers and presentations to be delivered at the 2019 Coordinate Metrology Society Conference (CMSC), which will cover research, innovations, best practices, and substantive application successes. Michael Raphael, president of Direct Dimensions and a veteran metrologist, will give the keynote address. The annual gathering is in Orlando, Florida, July 22 - 26, 2019.

In its 35th year, the CMS has long served the specialized needs of 3D measurement/inspection professionals and scientists worldwide, now including both the portable and traditional coordinate measuring machine (CMM) communities. The five-day event provides a welcoming, educational atmosphere for attendees and exhibitors to share experiences, challenges, research, concepts, and theory.

This event will mark the 35th year of the premiere conference dedicated to portable and traditional coordinate measuring machine (CMM) measurement professionals. Raphael will address the CMS with the presentation “The Future of 3D Metrology.” Raphael will draw upon his 30-plus years of experience to cover the metrology field and explore the evolution of 3D measurement solutions, scanning technologies, and digital modeling solutions for the wide range of applications and industries.

Raphael got his start in the field of 3D metrology in 1985 as an engineer responsible for solving aerospace manufacturing problems. He founded Direct Dimensions, Inc. (DDI) in 1995 to provide comprehensive 3D technical services, product representations, sales, and support for all types of 3D scanning, imaging, and dimensional measurement solutions.

The company employs nearly 30 technical and professional employees and performs hundreds of 3D scanning and modeling projects every year. He graduated from Virginia Tech with a BS degree in engineering sci-
ence and mechanics, followed by a Master of Engineering Administration degree from George Washington University.

CMSC will continue its slate of original content and broad selection of topics from emerging trends to the application of metrology techniques and technology. Subject matter is extensive, from the user-friendly “How to Get the Most Accuracy out of Your PCMM” to the high-level presentation “Tracker Kinematics and Uncertainty Using Quaternion.” Other experts share experiences such as “DKIST’s Journey of Using a Laser Tracker,” “Dynamic 3D Measurement of a Deployable Gossamer Antenna Structure Via Multi-Camera Photogrammetry in Zero Gravity,” and “Creating a New Concept in Performance-Built Sport Catamarans.” Application-level presentations will cover topics such as “Using Coordinate Measurement Machines To Shorten Time To Market For Aerospace Engine Components” and “Thickness Inspection of Composite Parts.”

Designed to empower the rapidly evolving measurement profession, the conference attracts metrology practitioners, quality control managers, manufacturing executives, scientists, students, and educators — hailing from prominent science/research laboratories, educational institutions, and industries such as aerospace, satellite, automotive, shipbuilding, power generation, and general engineering. Attendees are offered a wide range of educational experiences from technical presentations to the CMSC Exhibition Hall, home of the ever-popular Measurement and Education Zones. The CMSC program rounds out with certification examinations, workshops, training courses, networking events, an optional local tour, and post-conference access to all technical papers and presentation materials.

MORE INFO  www.cmsc.org

**Exact Metrology honors application specialist Greg Hoeting**

Exact Metrology presented its application specialist, Greg Hoeting, with the first Golden Circle Award.

This award recognizes Hoeting’s achievements at the company within the past 11 years. Among these are a positive and long-lasting impact on internal and external customers, going above and beyond normal job duties to help team members or customers, creating new solutions and opportunities, and innovative thinking. In addition, Hoeting perfectly exemplified the goals, purpose, beliefs, and ethics of Exact Metrology. He has also authored many articles, contributing to the body of knowledge at the company.

“Receiving the Golden Circle Award has been a great honor for me. Working at Exact Metrology is both challenging and rewarding. I continue to be fully committed to serving customers and contributing to the company’s development,” Hoeting said.

Steve Young, one of the company’s co-presidents said, “We are very happy to have Greg on our team. His dedication and knowledge are truly an asset for our company. We hope to continue offering this award in the future.”

MORE INFO  www.exactmetrology.com

### 38-Link™ adaptor for 38DL Plus® Gage boosts inspections

The new 38-Link™ adaptor for the 38DL Plus® ultrasonic thickness gage enables seamless data transfer using wireless LAN or Bluetooth®. The 38-Link adaptor connected to the 38DL Plus gage can wirelessly communicate to the Olympus Scientific Cloud (OSC), compatible apps, or a PC using the optional Link-Wedge PC software.

Adding the 38-Link adaptor to the 38DL Plus thickness gage turns it into a connected instrument that greatly improves efficiency and data management. Upgrading is easy; simply connect the adaptor to the gage’s protective rubber boot.

Communication to the Olympus Scientific Cloud using wireless LAN provides powerful workflow management tools (some Cloud features require a paid OSC subscription after an initial trial period). Users can organize and monitor the entire thickness gaging inspection workflow and see completion status. Inspection files can be created in the office and then wirelessly pushed to 38DL Plus thickness gages, shortening setup time. Inspectors can wirelessly transmit their inspection results from the field to the Cloud, making them immediately accessible.

The Olympus Link mobile app can be used to send thickness data from the gage to a smartphone or tablet, making it easy to share data using email or text message. The data can also be accessed using third-party compatible apps.

Data can also be sent from the gage to a PC using the optional Link-Wedge software. The wedge software runs in the back-
ground of your Windows 7 or Windows 10 PC and receives data from the 38-Link using Bluetooth. The software acts as a keyboard wedge and inserts thickness readings into any active data entry location, enabling the adaptor to populate thickness data into almost any Windows-based program.

MORE INFO  www.olympus-ims.com

Exact Metrology has successful open house in Brookfield

Exact Metrology hosted its annual open house at its Brookfield, Wisconsin, location June 6. Many old clients, as well as new ones, were on hand to learn about the company’s new technologies. Clients attended several breakout sessions to discuss Polyworks software, Geomagic software, and GOM CT scanning.

Jonathan Bourchard, the director of sales and business development at Polyrix, was on hand to talk about the company’s scanners and software. According to Bourchard, Polyrix is a 3D scanning system with unique technology based on structured light. The scanner takes images from all angles, so users obtain a 3D image without operator interference. Next, the scan can be compared to a CAD model with Polyworks. Reverse engineering also occurs through Polyworks. Bourchard said most materials can be scanned except translucent materials and shiny concave surfaces.

3D Parts Unlimited, a printing service bureau, not only replicates parts, the company also reverse engineers them. Scott Boese, the company’s sales engineer, said complex parts are sent to Exact Metrology. The parts are scanned, and an STEO file is sent. Next, 3D Parts Unlimited prints it and sends it to their customers. Boese expressed interest in GOM and wanted to purchase a Romer Absolute Arm.

Dean Solberg, Exact Metrology’s co-president, said the open house was meant to introduce clients to new technology in the 3D-scanning world. The GOM CT scanner is a high-accuracy and high-resolution scanner new to the U.S. market. Polyrix’s multiple light systems are activated with a single button and can scan both large and small parts quickly.

The Brookfield office is still expanding. Due to a continuous addition of equipment and capabilities, the space will soon be outgrown. As a result of its expansion, Exact Metrology has added a full-time training professional for Polyworks and Geomagic Design X and several contract inspection specialists.

Solberg said Exact Metrology has several opportunities for entry into new markets. One of these is its role as the only North American distributor of GOM CT scanners. The company is also excited about expanding in the Texas market.

Solberg said, “We are thrilled about the results of the open house, the attendees, and what the attendees learned. We look forward to holding this annual event again and introduce our customers to more and better technology.”

Exact Metrology is an ISO 9001:2008, AS9100, FFL and ITAR Certified Company.

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“Everyone’s been after change-over, and that’s something that we do very well: being able to give customers the ability to change over quickly from one job to the other.”

What do you do in your position at Hainbuch America?
I cover parts of Ohio, Indiana, and Michigan, and I promote Hainbuch sales.

What advances in workholding has Hainbuch developed over the last two years?
A couple things that we have brought on board is what we call our MAXXOS mandrels. They used to be strictly special, and now we brought them out where they’re more of a standard item. The difference is, instead of a round taper on the clamping element, which we call a bushing, now we have more of a pyramid shape.

What that does for us is it gives us more rigidity, and — actually — more torque for some applications where we’re putting a lot of load on the OD of the part while we’re machining it. Because of the way the bushing and the taper meet, it actually keeps contaminants out much better than the round, tapered cylinder.

We also came out with the micro mandrel, which goes down to 5.5 millimeters, and it’s still a little bit of a special, but it allows customers to do the smaller clamping diameters with a grinding wheel or with a hob.

We also have the G211. They were just coming around two or three years ago, but I call that our job-shop mandrel. When I say job shop, it is something that is off-the-shelf, and we use standard bushings, and we can cover a range 18 millimeters up to 120, 130 millimeters with off-the-shelf components. For the gear industry, it’s usually fairly special almost in everything, but this allows customers to be able to maybe start with one mandrel and then get another job, and they can get something ready quickly to do another maybe bigger job.

Have your customers’ demands for workholding solutions changed over the last few years?
I would say more people are looking for better solutions, like a little more rigidity. They’re willing to spend a little more money for a good solution instead of just trying to wing it, I guess you would say. There’s a lot of old tooling still out there, but I see more — even with these smaller shops now — customers spending more money to get a better product.

Everyone’s been after change-over, and that’s something that we do very well: being able to give customers the ability to change over quickly from one job to the other, but we also offer special solutions for long running. We also offer that special solution that is geared for maybe one or two parts.

Has the Industrial Internet of Things played a part in the direction that you’ve taken with future products or current products?
The industry always leads you. Our customers always lead us to find better solutions, but yes, I would say that they have led us to that — or we lead them.

Hainbuch’s G211 is what’s considered a “job-shop mandrel.” (Courtesy: Hainbuch America)

How do you help those customers decide what kind of workholding they need?
Hainbuch has over 150 patents in their history, so they’re always looking to develop a better product. But you always listen to your customers. And they usually ask for something that you think is impossible ... until it’s not.

Is Hainbuch exhibiting at Motion + Power Technology Expo this year?
Yes, it’s here in Detroit as a matter of fact.

What should attendees expect at your booth?
You’ll see our full line of gear products and both OD and ID for the gear industry. We’ll be showing our MAXXOS Mandrels, 213s, our G211s, our micro mandrels, and some of our simple stationary workholding for doing shaping and things like that.

I was just at a customer this afternoon, Delta Gear, and they use quite a bit of our stuff, just some really inexpensive workholding that they just love for the quick change-over for some simple jobs that they do.

Anything you’d like to add that Hainbuch’s working on?
Our U.S. operations are growing. We’re adding new people. We’re going to be expanding our machine shop here. I was just told last week that we might even blow the doors out a little bit for a major expansion, so we’re going to be doing more product here in the U.S.
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