gear TECHNOLOGY®

AUG 2016

IMTS 2016

SHOW PREVIEW; INTERVIEWS; BOOTH INFO

CHAMFERING AND DEBURRING

AUTOMOTIVE GEAR MANUFACTURING UPDATE

GEAR-CUTTING ADVANCED ENGINEERING STEEL

TRANSIENT EHL ANALYSIS OF HELICAL GEARS

FFG Modul CDA 250 Automated chamfering & deburring

Star SU carries a line of FFG Modul chamfer/deburring machines that best suits your requirements, whether you opt for a standalone machine (CD 250), an automated solution for your line (CDA 250) or a flexible all-in-one (CDX 250).

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IMTS2016
International Manufacturing Technology Show
September 12 - 17, 2016 · McCormick Place · Chicago

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Generating Grinding 8mm- 1,250mm


Profile Grinding 8mm- 8,000mm

A QUIZ

Question 1:

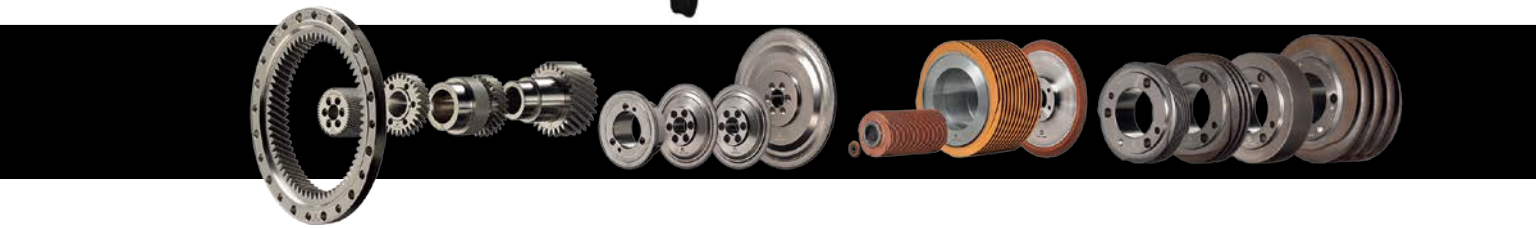
What do you want? A machine that will grind your parts perfectly and efficiently, so you can go home and be with your family.

Question 2:

What do we have? See answer to question 1.

See the ZE 800 and KX100 in our booth at IMTS.

Family friendly machines.



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departments

Cover photos by David Ropinski

Liebherr Performance.

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September 12 - 17, 2016
Chicago, USA
North Hall, Booth N-6930

New shaping machine LSF 180

During the development of the new shaping machine in the 180 mm working range, the focus was on high flexibility and productivity. With the new movable shaping head a variety of different workpieces with different lengths can be machined. Cluster gears can also be easily shaped with this machine in one clamping set-up. This LSF 180 is ideal for every user in gear manufacturing.

- Movable shaping head
- Short setup times thanks to NC axes
- Tool interface: SK 40
- High productivity with 1,500 double strokes/min
- Two-track cam system with automatic adjustment
- Very efficient automation

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LIEBHERR

THE GEAR INDUSTRY'S INFORMATION SOURCE

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Full IMTS 2016 Coverage

Check *www.geartechnology.com* early and often for our comprehensive IMTS 2016 coverage including booth previews, interviews with show personnel, show-specific e-newsletters and blog updates from the Gear Pavilion. Drop by *www.powertransmission.com* to get updates on co-located shows like Motion Drive & Automation (MDA) and Industrial Automation North America (IANA).

Gear Talk

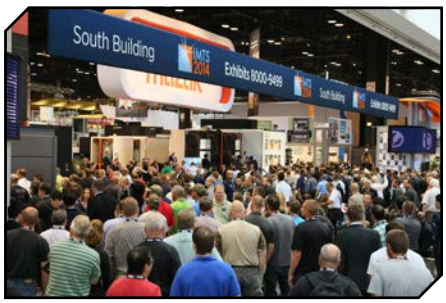
Gear Technology technical editor and resident blogger Chuck Schultz weighs in on some important gear topics on the homepage:

In *Visit Us on Social Media*, Chuck discusses the role social media can play in the pages of this magazine including feedback for our popular *Ask the Expert* column.

In *Spare Parts,* Chuck examines shop floor inventory and the importance of having the right parts around to accommodate all customer requests.

Trade Show Tour Guide

Are you exhibiting at an upcoming trade show? Are you currently planning your fall schedule around the manufacturing trade show circuit? Browse our *Gear Industry Events* page here (*www.geartechnology.com/events.htm*) to see what events are coming up including IMTS 2016, AMB 2016 and Fabtech 2016.



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BPA WORLDWIDE BUSINESS

We're Adding Strength To Our Sales and Marketing

As a world leader in the production of high-precision gears, with a new high volume production facility, we've never been in better shape. But we need a Manager of Sales to make us even stronger.

Good fit?
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kyoung@forestcitygear.com

FOREST CITY GEAR

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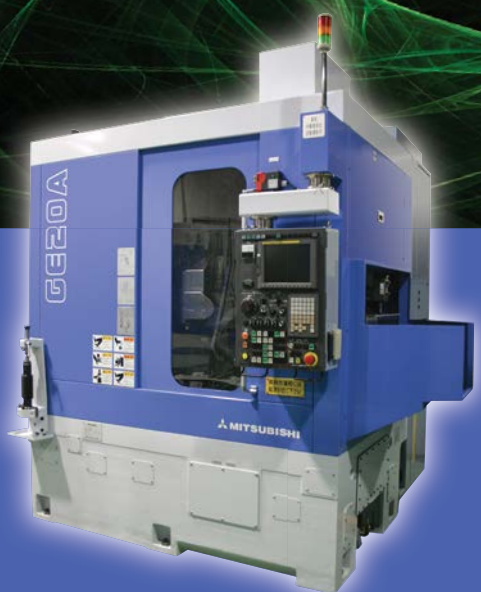
HEAVY INDUSTRIES AMERICA, INC.

Our Technologies, Your Tommorow

The Advantage of Supreme Productivity



GE20A
GEseries

The Game-Changing Mitsubishi GE Series CNC Gear Hobbing Machines.

A quick glance at Mitsubishi's GE Series Gear hobbing machine doesn't reveal the truth behind it's real power. However, when you evaluate the output the full picture is dramatic and clear. With an all new, utlra-efficient dry cutting design, the GE series machines produce gears up to 50% faster than previous technologies—with all the precision your specifications demand. This kind of boost in productivity is sure to help you be more competitive in the marketplace and pump up your profits. Experience the world-class performance of the GE series hobbing machines at **www.mitsubishigearcenter.com** or contact sales at **248-669-6136**.

IMTS2016
BOOTH #N-7046

Seven Ingredients

Publisher & Editor-in-Chief
Michael Goldstein

Chicagoans are very particular about their hot dogs. To begin with, it has to be an all-beef product, served on a steamed poppy seed bun. But just as important are the essential toppings. If you walk into a proper Chicago hot dog stand and order it "Chicago Style," you'll get exactly these seven ingredients on your dog: yellow mustard, chopped white onions, neon green pickle relish, a dill pickle spear, tomato wedges, sport peppers and, of course, celery salt.

Oh, and if you ask for ketchup, you'll get — at a minimum — rude stares and sarcastic comments. In some joints, you might just be asked to leave.

The reason this is important is that many of you will be heading to Chicago soon for IMTS, which takes place at McCormick Place from September 12–17. The biennial manufacturing trade show is the biggest display of machine tools and manufacturing technology available in America. So if you're in the business of making things, and you want to stay up to date about the latest machines, tools and processes, there's no better event to attend.

But just like a Chicago hot dog, having a successful IMTS experience requires the right combination of ingredients:

1. **Plan Your Day(s).** The show is overwhelmingly large. The 2016 event will play host to more than 2,000 exhibiting companies covering more than 1.3 million square feet of exhibit space. It occupies all of Chicago's McCormick Place, and you'll wear yourself out going back and forth between the North, South, East and West buildings, each of which will host several pavilions. More importantly, you can be distracted by a lot of exhibits that aren't as relevant to gear manufacturing or to your current needs. Don't just show up and wander the aisles. You'll be lost and won't accomplish anything. We've tried to help you organize your time by putting together a gear manufacturers guide to the show, beginning on page 37.

2. **Set Up Appointments.** Let the exhibitors know you'll be coming. If you have questions, don't count on the right person being available to answer them when you show up at their booth. Trade shows are extremely busy, and if the expert you need is busy talking to another customer, you could be stuck waiting for an hour or more.

3. **Divide and Conquer.** If you have the luxury of sending multiple people to the show, do it. Nobody can cover the whole show on his own. Split up responsibilities among your staff and put together a buying team.

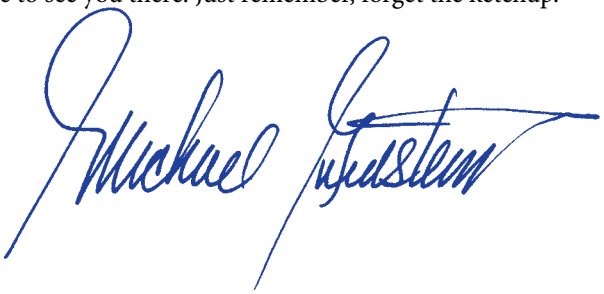
4. **Expand Your Horizons.** Don't just visit the suppliers you already know. The world of gear manufacturing is constantly changing. New processes and technologies are continually being advanced. This is the best opportunity you'll have to see them up close, ask questions and learn how they might fit into your operation.

5. **Learn.** IMTS includes a number of educational conferences and meetings that could be important to you. Don't forget to schedule these special opportunities. They are more of a time commitment than booth hopping, but the payoff is worth it.

6. **Visit Gear Technology (Booth #N-7324).** Be sure to stop by our booth to say hello, chat with our editors or let us know how we're doing. While you're there, please renew your free subscription. We'd really appreciate it.

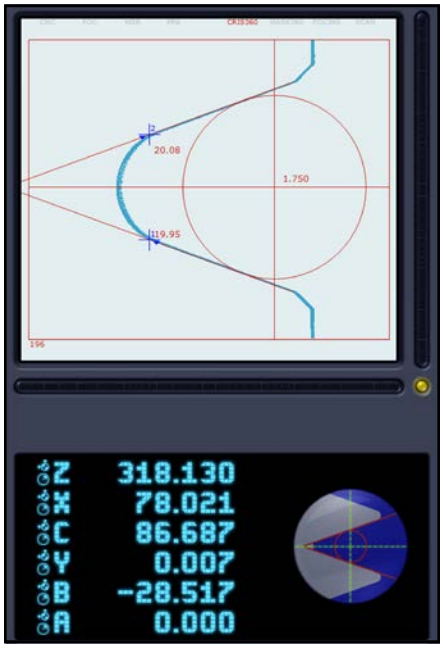
7. **Take Advantage of Chicago.** Truly one of the most beautiful cities in the world, Chicago has a lot to offer. If you're making a special trip to the show, carve out some time to take in a museum or go on an architectural tour. Chicago's architectural heritage is second to none. Visit the Museum of Science and Industry, and you'll see the only remaining building from the 1893 World's Columbian Exposition. And don't forget to eat. Even if hot dogs aren't your thing, you should also try our world-famous deep-dish pizza or have yourself an Italian beef sandwich (dipped, of course) with sweet or hot peppers, or my personal favorite, Polish sausage, Chicago style.

If you follow the recipe, you should have a great IMTS. We hope to see you there. Just remember, forget the ketchup.

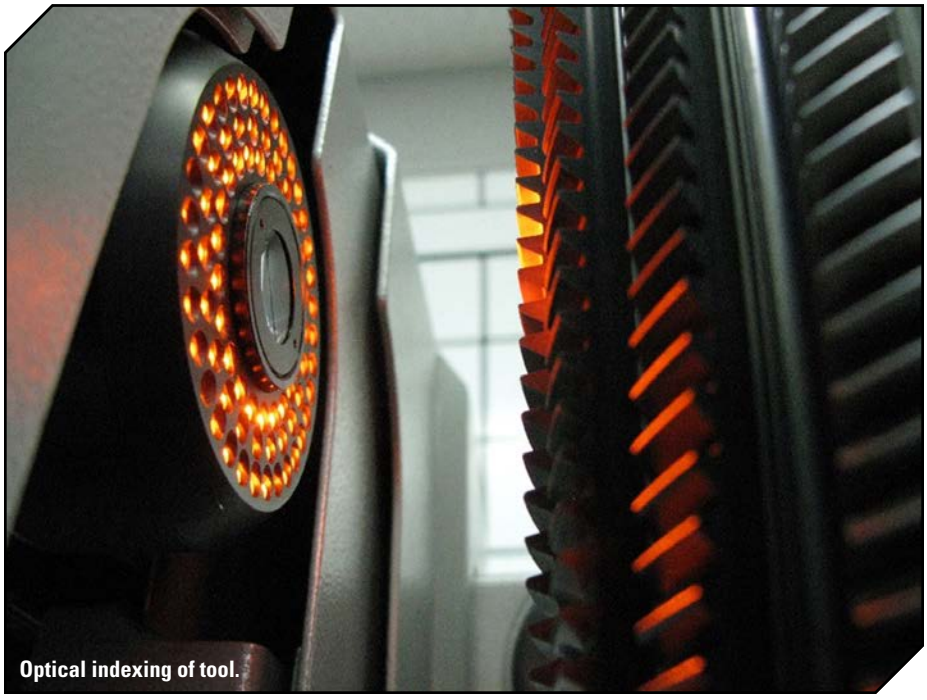


Star SU Uses Virtual Inspection and Cut Simulation

Recent changes in automotive technology include a move away from hydraulic to electric steering systems. For Star SU, that means much tighter tolerances in the manufacture of rack milling cutters at their Tawas, Michigan plant.



Generated tooth contour with simulated wire.



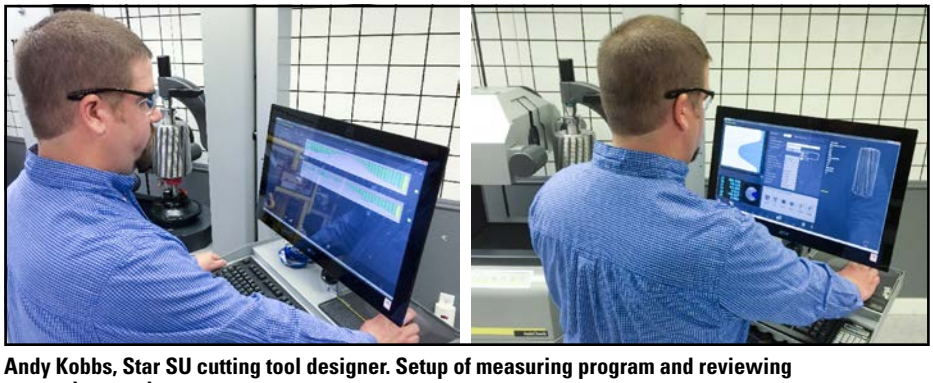
Optical indexing of tool.

The Challenge

Today's steering systems contain highly engineered rack and pinion components. The complexity and precision of these components require cutting tool measurement techniques not found on standard inspection equipment.

Recently, Andy Kobs, Star SU cutting tool designer, met Werner Lueken, Zoller inspection product manager, at a meeting of AGMA. They discussed the need for a special application to measure and inspect the rack milling cutters Star SU manufactures. Lueken offered a new solution in the form of measuring and inspecting the milling cutters visually, and to the micron, using the Zoller hobCheck system.

These milling cutters may have teeth in alternating patterns and asymmetrical forms, making elemental inspection difficult. To solve this, Zoller simulates the cut and develops a virtual rack template. The hobCheck allows Star SU to simulate the test on the rack before the tool leaves their plant.



Andy Kobbs, Star SU cutting tool designer. Setup of measuring program and reviewing measuring results.

Implementing the Solution

To satisfy the need for micron-level measurements, Zoller developed software for the hobCheck based on Star SU's specific requirements for measuring and inspecting rack milling cutters. With the hobCheck, Star SU can measure and inspect a cutter in about 20 minutes with extreme accuracy.

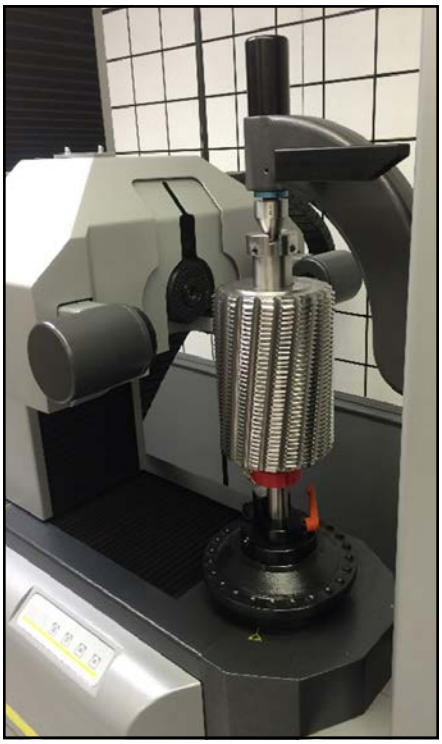
"It has allowed us to work in significantly greater detail — to the micron. We can do things we couldn't do before. Prior to getting the hobCheck, we used standard and specialized probing machines to measure rack milling cutters. Although very accurate, they did not output a composite of what the tool will produce. Now we have that capability," Kobs said.

The Future

Star SU is interested in adding more Zoller 3-D capabilities. Thomas Ware, product manager of Gear Tools said, "We also like the way Zoller uses graphics and other visuals that make using the machine easy and quick. Operators expect ease-of-use in equipment — more now than ever.

"Another application we are looking at is measuring and inspecting saw blade milling cutters that put the teeth in band saw blades. Those cutters aren't easily manually checked. The cutter elements can be checked more accurately with the hobCheck," Ware added.

Star SU offers RFID chips with their hobs and is working with Zoller to capture the tool information required by the customer. For example, after reconditioning, the dimensional changes in the tool can be downloaded directly to the customer's machine via the RFID chip.



hobCheck with tool between centers.

Star SU's manufacturing facility in Tawas, Michigan offers a full range of gear cutting and inspection tools to a broad range of gear tooth manufacturers. One application primarily serving the automotive industry is the steering rack milling cutters that cut racks for rack and pinion steering mechanisms.

The Zoller product portfolio encompasses tool presetters, measuring and inspection machines, and tool management software, which are demonstrated in our showrooms and on-site around the world.

The Zoller hobCheck universal measuring machine opens unprecedented opportunities for fully automated and economical complete measurement of carbide or HSS hob cutters. All parameters are measured automatically through the intelligent combination of image processing technology. CNC axes and touch probes benefit from improved tool quality, shorter setup times during re-sharpening and complete documentation.

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www.zoller-usa.com

For more information on the Zoller hobCheck universal measuring machine, follow this link: *http://zoller.info/en/products/inspection_measuring/universal_measuring_machines/hobcheck*

Sandvik's Coromill 174 Gashing Tool

OFFERS FLEXIBILITY IN LARGE GEAR CUTTING

The new Coromill 174 flexible gear cutting disc from Sandvik Coromant is designed for roughing or finishing small to medium batches of spur or helical gears. Its primary advantage is increased flexibility, as one cutter body can handle a range of modules or DPs.

"The same disc can be used for a range of DPs/modules and a range of tooth counts both for internal and external gears," says Gear Milling Americas Manager, Nicklas Bylund. In fact, Bylund says, it takes only three bodies to handle the entire range from 2.5 DP to 0.5 DP.

In addition, variation of pressure angle is also possible from 20 to 25 degrees.

The tool uses inserts that are ground to form, with a minimum order of 25 inserts. The tools are capable of producing gear quality up to DIN 7/AGMA 10 (according to AGMA 2000-A88) on tooth forms module 16 and larger using good machines, with DIN 8/AGMA 9 being typical results.

There are some limitations to the cutters when it comes to lower tooth counts (less than Z=25, for example). In those cases, Sandvik recommends a separate Coromill 174 disc for pinions.

"The time and cost savings using an inserted disc compared to a HSS hob are substantial for big teeth, both for roughing and finishing," Bylund says. "An inserted disc is several times faster than an HSS hob, and the cost of using ground-to-form finishing inserts, compared to several regrinds on a big hob, is often lower."

In addition, Bylund says, "CoroMill 174 is ideal for the customer making spare parts or small series since the investment in the tool body can be spread over several parts, and one single batch of inserts can be ordered for each particular gear."

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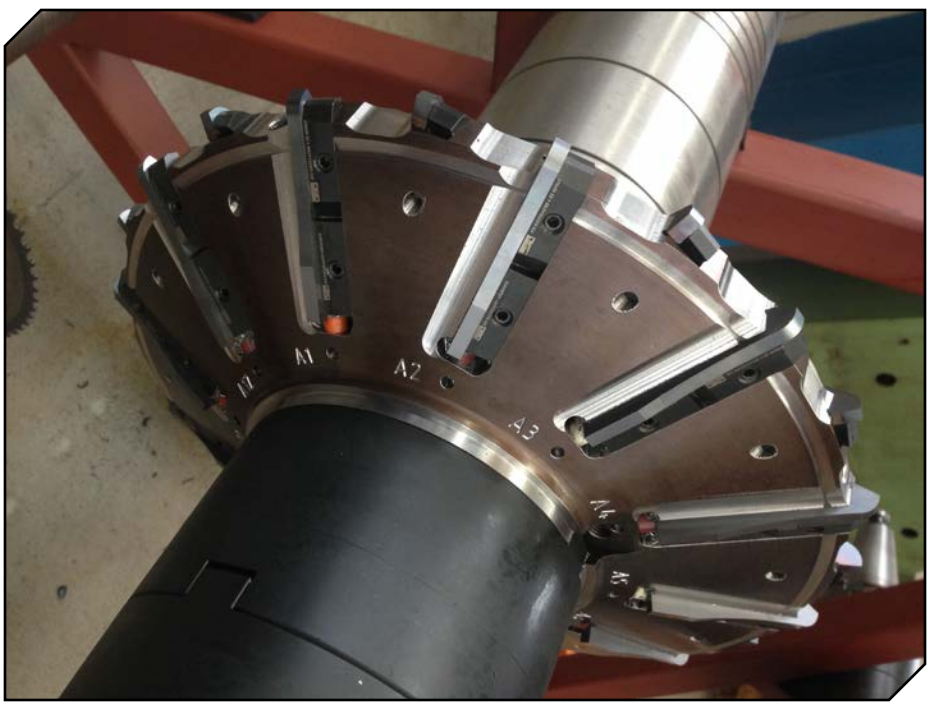
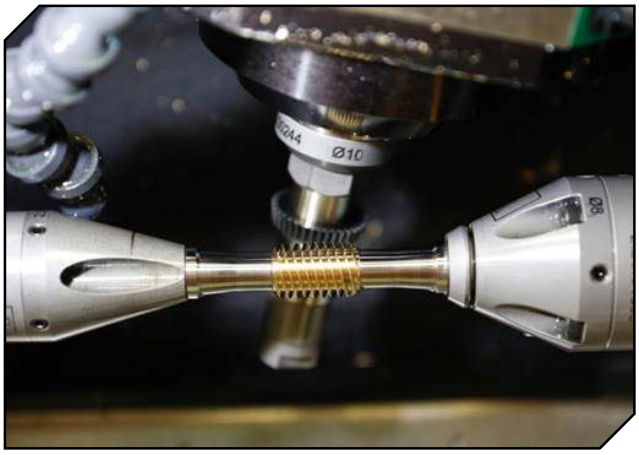


Affolter Technologies

DEVELOPS WORM POWER SKIVING MACHINE



Affolter Technologies SA, a technology and market leader in micro gear hobbing machines for the aerospace, medical and micromechanical industries, is introducing an innovative new technology: worm high-speed power skiving.

"This new development will increase the productivity and efficiency of manufacturers in the automotive and aircraft industries considerably," said Managing Director Vincent Affolter. "With this technology, we can finish a high-precision worm in about six seconds, about four times faster than with the previous methods. Reducing cycle time by such a large step will help any worm-shaft manufacturer."

This new technology will help manufacturers of high volume precision worms significantly. Speed and accuracy are the main focus for small worms with a module of 0.3 to 1. "We recently saw a big demand in the automotive industry. Such worms are used in car seats or trunks, but also in other sectors," Affolter added.

Unlike conventional worm hobbing, where the hob turns much faster than the workpiece, the Affolter engineers inverted the process. The workpiece turns extremely fast, with up to 12,000 rpm, while the new cutter (similar to a special lathe bit) turns much slower and rotates into the part. This process is only possible with a machine that can reach such speeds while providing the necessary rigidity and stiffness like the Affolter AF100 and AF110.

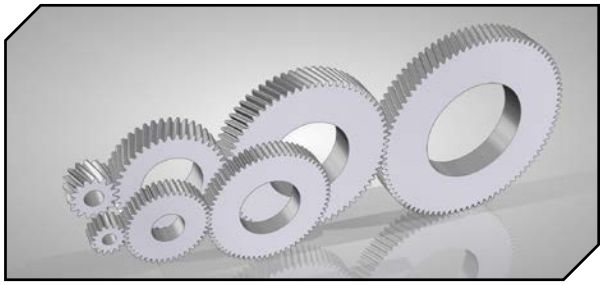
The integration of such high speed spindles into the existing Affolter Gear Line machines was the first step of the process. Currently, the Affolter R&D team is focusing on an optimized machine base including peripheral support devises. The new skiving process produces an increased amount of chips, that will be addressed with a new "chip disposal device." In addition, efficient and ideal coolant supply is of high importance and is being examined by the Affolter team. It is important to keep the kinematics of the machine the same. Affolter is represented in the United States and Canada by Rotec Tools Ltd.

For more information:
Rotec Tools Ltd. (Affolter Technologies)
Phone: (845) 621-9100
www.rotectools.com

GWJ Technology GmbH

OFFERS NEW CALCULATION MODULES FOR CYLINDRICAL GEARS

GWJ Technology GmbH, a manufacturer of calculation software for machine elements and gearboxes, has upgraded its web-based calculation software *eAssistant* — the engineering assistant — with two new modules for cylindrical gears. Brand-new modules are the modules for three- and four-gear train systems. These modules allow a fast and easy calculation of geartrain systems with three or four spur or helical gears.



The new modules have all typical functions of the *eAssistant* cylindrical gear pair module to determine the geometry. To calculate the load capacity, the standards DIN 3990 and ISO 6336 are available. Alternating stress of the tooth root is automatically taken into account for the intermediate gears. Furthermore, there are new versions of the popular *eAssistant* 3D CAD plugins for *Solidworks*, *Solid Edge* and *Autodesk Inventor*.

The plugins enable the user to open all *eAssistant* calculation modules directly through the CAD menu. At the push of a button, the part, including the accurate gear tooth form, can be created as a 3D part on the basis of the previously calculated data. With just one click, the design table with all manufacturing details of the gear can be placed on the manufacturing drawing. The appearance and size of that table is individually configurable. In addition, *eAssistant* supports the output format DXF.

The *eAssistant* software allows calculation, design and optimization of machine elements, including shafts, bearings, gears, bevel gears, shaft-hub connections, bolted joints, timing belts and springs.

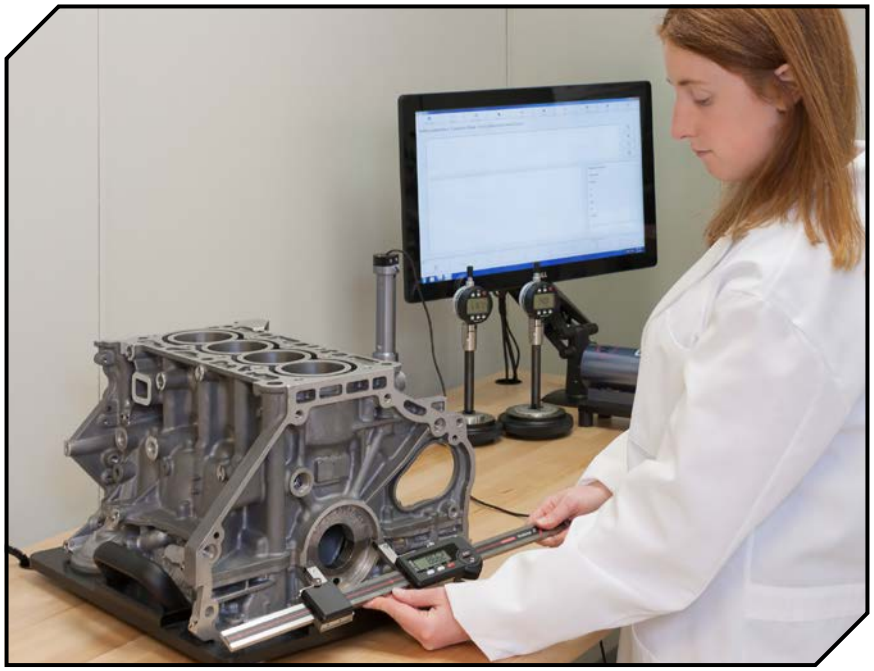
The software is available in a variety of pricing plans, including pay-as-you-go plans that allow the purchase of blocks of time on the system. Interested individuals can apply online for a free test account, which allows up to five hours of credit to try it out. Visit *www.eassistant.eu* for more information.

For more information:
GWJ Technology GmbH
Phone: +49 (0) 531-129 399-0
www.gwj.de

Mahr Federal Digital Universal Caliper

OFFERS NEW MEASURING RANGE AND ACCESSORIES

With its broad range of measurement accessories, the new Multimar 25 EWR Digital Universal Caliper from Mahr Federal is a versatile and configurable caliper for ID and OD measurement requirements. Available in four capacities with outside measuring ranges up to 1,250 mm (50 in.), the 25 EWR can measure outside and inside dimensions, narrow collars, external and internal tapers, dovetails, grooves, distances between hole centers, for centering shoulders, scribing workpieces and more.



Unlike standard calipers, both measuring arms of the 25 EWR can be moved along the beam, thus functioning like a beam-gage, and providing well-balanced weight distribution even with small dimensions. The application range can be easily extended by reversing the interchangeable measuring arms. Plus, the digital display is always in the operator's line of vision due to the patented mounting fixture of the measuring arms and attachments provided.

But what makes the Multimar 25 EWR so versatile is the wide range of measuring arms, anvils, mounting attachments and depth stops, which can be configured by the user. Anvils and tips are available in a wide variety of shapes and configurations, including threads, flat and spherical shoulders, blades and round faces. Depth stops can be set to the exact measuring depth in the horizontal measurement position to provide precise support on the reference plane surface. This improves repetitive accuracy when conducting comparison measurements in the second axis, and when used with a rectangular gage block, can provide accurate depth measurement on cones.

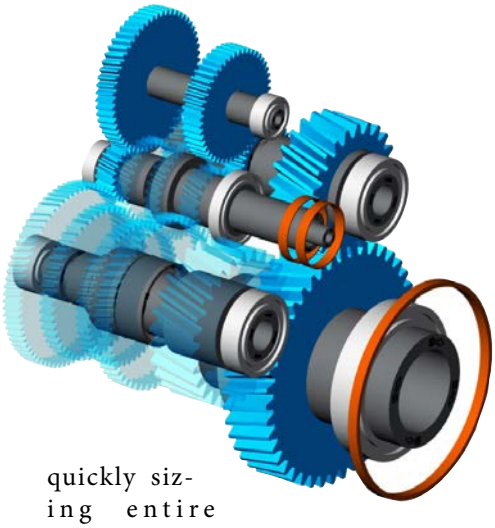
Data output is via USB, Digimatic, Opto RS232C, or wireless, and battery life is about three years. The Multimar 25 EWR Universal Caliper provides IP 65 protection for all workshop conditions, and is supplied with battery, instruction manual, hardwood mounting and resting blocks and a finely crafted wooden case.

For more information:
Mahr Federal Inc.
Phone: (800) 343-2050
www.mahr.com

KISSsoft

INTRODUCES RAPID 3D MODELING IN KISSSYS

Modeling in *KISSsys* has been radically simplified in the latest *KISSsoft Release 03/2016*. Now, for example, when elements are added, the part geometries are prefilled with default values. At the same time, the shafts are positioned intelligently, to suit the gearing types involved, such as a cylindrical gear pair, a bevel gear or a planetary stage. The user can now see the modeling progress immediately in the 3D view. Another new feature is the option of adding assemblies (such as planetary stages) to a model, and also adding shafts, if required. Would you like to find out more about *KISSsys* functionalities for quickly sizing entire drivetrains? Training courses (held in English) e.g. Basic Training, which runs from August 30 to September 1, and Planetary Stage Gearboxes, which runs from December 6-7, are the ideal opportunities to attend and learn from KISSsoft software experts.



For more information:
KISSsoft USA LLC.
Phone: (815) 363-8823
www.kisssoft.com

Riten Industries Disk Driver

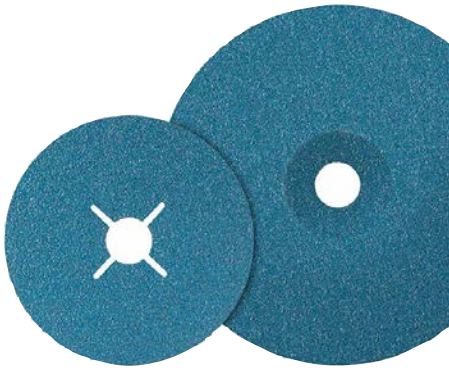
DESIGNED TO HOLD DIAMETERS TWO INCHES OR LESS

Riten has introduced a modified face driver specifically designed to hold workpieces with diameters of two inches or less. In lieu of individual drive pins, the unit features a multi-toothed drive disk that securely penetrates the face of the part. It is ideal for gear hobbing and other aggressive machining operations.

The disks are available in a choice of diameters, similar to the driving diameters on standard face drivers. The teeth configuration is designed to allow the disk to be bi-directional—for both clockwise and counter-clockwise rotation. This also compensates for the backlash common to gear hobs. The driver features three stirring screws which move the disk and center point radially to compensate for misdrilled center holes and other concentricity issues in the workpiece or machine.

Walter Surface Technologies

OFFERS IMPROVED TOPCUT DISC FOR FINISHING OPERATIONS



Walter Surface Technologies has introduced the new and improved Topcut sanding disc, one of the latest additions to the company's finishing solutions. The Topcut sanding disc now features a new formulation of blue zirconium grain blend to remove more material, faster. The new blend contains a higher concentration of Zirconium, according to Jonathan Douville, product manager, Surfox, E-Weld and finishing solutions at Walter Surface Technologies. "The new and improved discs remove material 50 percent faster than the previous model, and also have a longer lifespan," Douville said.

The new grain blend is designed for finishing applications on steel and stainless steel and offers maximized stock removal on any given surface. The disc also guarantees cooler sanding so that the metal will not overheat. "The cooler sanding helps to preserve metals, especially the heat-sensitive material, and will result in a beautiful, finished product," continues Douville.

Topcut comes in Walter's exclusive 50-pack protective packaging designed with humidity control to preserve the wheel's physical properties until ready for use. Discs are also available in the standard pack of 25.

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The Riten Disk Driver is available in standard straight shanks and Morse tapers. Special tapers are available on request.

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Mitutoyo America Corporation introduces the 519 Series of high-accuracy Mu-Checker probes and displays. These electronic gaging systems are suitable for a range of applications from the inspection room to production-line integration.

High-resolution lever-head probes allow multi-point measurements of small parts, flatness and straightness measurement on X/Y table, as well as runout measurement of shafts. The cartridge-head type is easily built into equipment due to its slim and compact shape, making it optimal for an automatic measuring machine. Probes are offered with a standard measuring force of 0.2 N, or a low measuring force of 0.02 N. The low-force style enables soft workpieces to be measured without significant deformation. Optional styli, extension rods and brackets are available.

Both digital and analog display models offer zero setting with the touch of a button. Additional models allow for multi-probe measuring systems.

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Siemens Industry Inc.

OFFERS SMART OPERATION FOR FLEXIBLE AND EFFICIENT MANUFACTURING

Siemens presents a new concept for efficient work processes surrounding the Sinumerik 840D sl CNC in the form of Smart Operation. Shop floors will benefit from the use of Smart Operation, as it allows work at the machine tool to be performed with greater flexibility and speed and helps boost productivity. The new concept encompasses aspects such as job preparation, IT networking, improved usability with touch operation and the use of mobile devices to perform monitoring and control functions. In short, Smart Operation simplifies the integration of machines into the production process. Smart Operation does not require support by IT specialists and can be simply implemented independently by machine operators — meaning that companies can implement the individual functions using minimal financial and organizational resources.

Smart Operation encompasses four areas: Smart Prepare, Smart Operate, Smart IT and Smart Mobile. Smart Prepare is concerned with job preparation and the generation of CNC programs at the PC. Siemens offers high-

performance software for this purpose in the form of *Sinutrain*. Known as control-identical training software, *Sinutrain* is used as an offline programming workstation. Users will benefit from programming and simulating the next job ahead of time offline at the PC and shop floors can make significant gains in terms of productivity at the machine.

Smart Mobile is a solution designed to enable the use of mobile devices in the machine tool environment. Using a secured webserver, users can deploy monitoring and control functions using a notebook, smartphone or tablet. This allows up-to-the-minute information such as the current job status or component supply situation to be accessed remotely or service information to be displayed. These functions can benefit machine tool builders from the early development stage of new machine concepts, allowing mobile access to be included as a standard feature from the start.

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Chamfering and Deburring – the Underrated Process

Gottfried Klein, Director of Product Management Hobbing and Chamfering/Deburring, Gleason Corporation

Chamfering and deburring of cylindrical gears does not get much love from manufacturers. The process is seen as a necessary evil since it is adding cost without adding "value." However, there are good reasons for not underrating this important auxiliary process. Chamfering and deburring takes care of several issues which may come up during the manufacture of quality gears.

First of all, chamfers prevent damages in gearboxes if acute edges or remaining burrs from the hobbing or shaping process become brittle during super-carburization in the heat treatment process. Under load these extensions can break off and hardened particles can reduce transmission life causing major damages with premature transmission failure.

From a gear manufacturer's view, burrs have a negative impact on the cost-per-piece produced, respectively tool life in subsequent finishing processes like honing. A hardened burr will eat away finishing tools, typically at the same spot wasting precious tool life and resulting in more dressings required, adding even more cost. When gear faces are used for clamping or locating purposes burrs are not allowed either. In part handling, chamfers prevent damages like nicks when parts are handled on automation systems where workpieces can touch. And finally, when handling workpieces manually sharp burrs can injure operators. These issues can be avoided by choosing the proper chamfering and deburring technique.

Over the years several processes have been developed to remove burrs effectively and to chamfer gears with an undefined or defined chamfer.

The following article will focus on efficient processes which can create consistent and defined chamfers. For this reason we will not elaborate on electrochemical deburring or chamfer grinding.

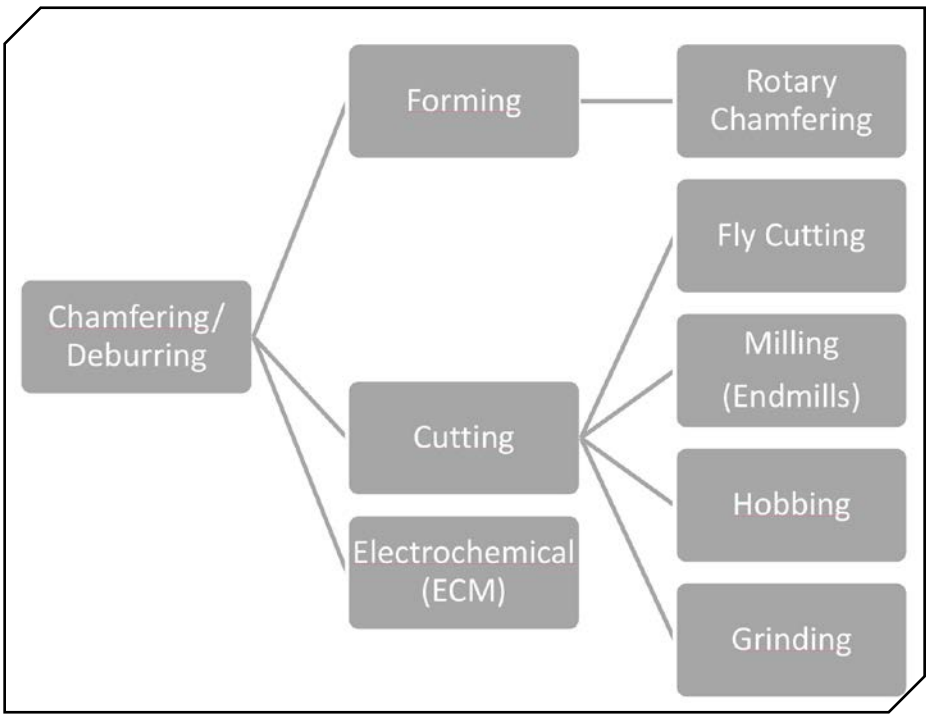
Forming Chamfering

The process most frequently applied for smaller cylindrical gears up to module 5 mm is rotary chamfering. It covers most gear geometries and is an extremely fast process which makes it applicable for even the smallest applications like planetary pinions which feature cycle times below 10 seconds.

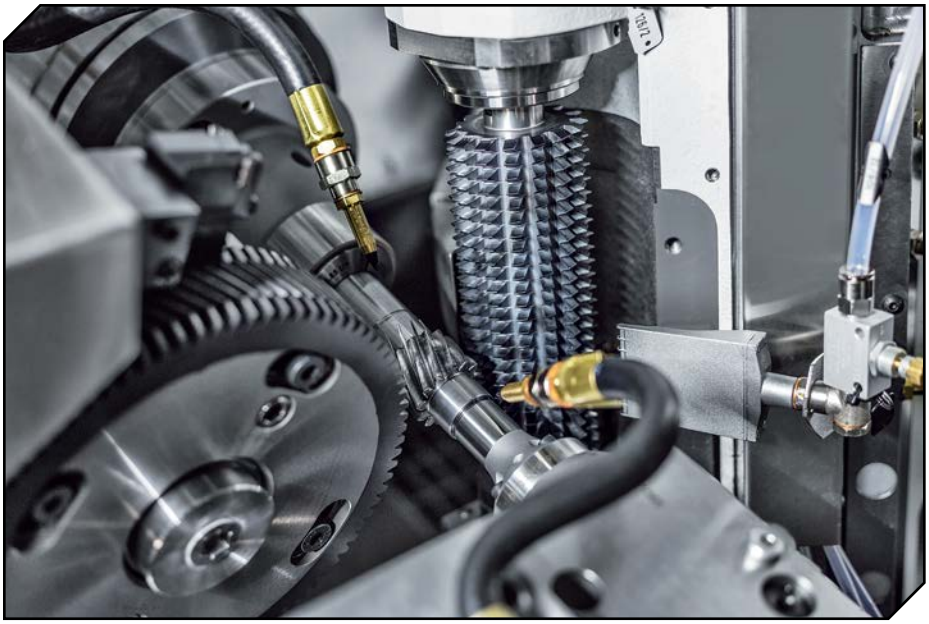
Rotary chamfering is a forming process which creates chamfers along the tooth edges by gear shaped tools which are meshed with the workpiece. Material flows mainly to the face side of the gear where it is cut away by single blades, deburring discs or file discs, depending on the gear shape and/or the machine configuration. Unfortunately some material can "flow" into the gear tooth flank, the so-called "secondary burr." While shaving or threaded wheel grinding can easily cope with this small bulging of material, a subsequent honing process requires a better quality input, in order to not jeopardize the comparably expensive tool life. Two strategies are used to get bulging free flanks: Either edge zone burnishing or a two-cut hobbing process.

For edge zone burnishing special rotary chamfering tools feature a 180 degrees chamfering section and another 180 degrees section with burnishing functionality. Secondary burrs on gear flanks generated by rotary chamfering discs are rolled down into the flank surface leaving only the required stock for the subsequent finishing process and keeping nevertheless the required scallop depths.

The two-cut hob process regularly features a pre-cut and a final pass with the rotary chamfering process in between both cuts. Secondary burrs in the flank are removed by the second hobbing pass. As the second pass is determining quality and remaining stock for the following honing process, cutting parameters are chosen to keep the total hobbing time close to a one-cut process. Unless a double spindle machine is used the sequential chamfering usually amounts only to an additional 4–5 seconds. This process



Typical processes used for chamfering and deburring of gears.



Rotary chamfering/deburring on an integrated station for subsequent chamfering/deburring of geared shafts, Gleason P90iC.

strategy also works well for finish hobbing applications which require chamfers.

Rotary chamfering produces chamfers with angles in the range of 20–30 degrees and — depending on the application — even beyond this range. The process provides constant results with comma-type or parallel chamfers, root chamfers, acute or the obtuse chamfers. Due to short machining times and long tool life it is the process of choice for medium and high volume production of cylindrical gears.

Cutting of Chamfers

An alternative to rotary chamfering is cutting the chamfer. Several methods are available: Let's start with **chamfer hobbing**. Chamfer hobs can be either mounted on the main hob spindle itself or by means of some kind of station attached to or integrated into the machine. The benefit of an additional, separate station is the time-parallel processing of the auxiliary task which allows the chamfering process to be executed in completely masked time. Another benefit of a separate station versus mounting chamfer hobs on the main spindle is the less complicated, "fiddly" setup procedure and the independent tool change when required. Cutting chamfering provides a defined chamfer with minimum secondary burrs which again is ideal for subsequent hard finishing processes like the honing process. Compared to the rotary chamfering process collisions have to be avoided when machining e. g. cluster gears. On the other hand modules larger than 5 mm, which would be the limit for rotary chamfering, would not be a problem to chamfer. Since the tool is workpiece-dependent this process is preferably used for medium and high volume production like automotive.

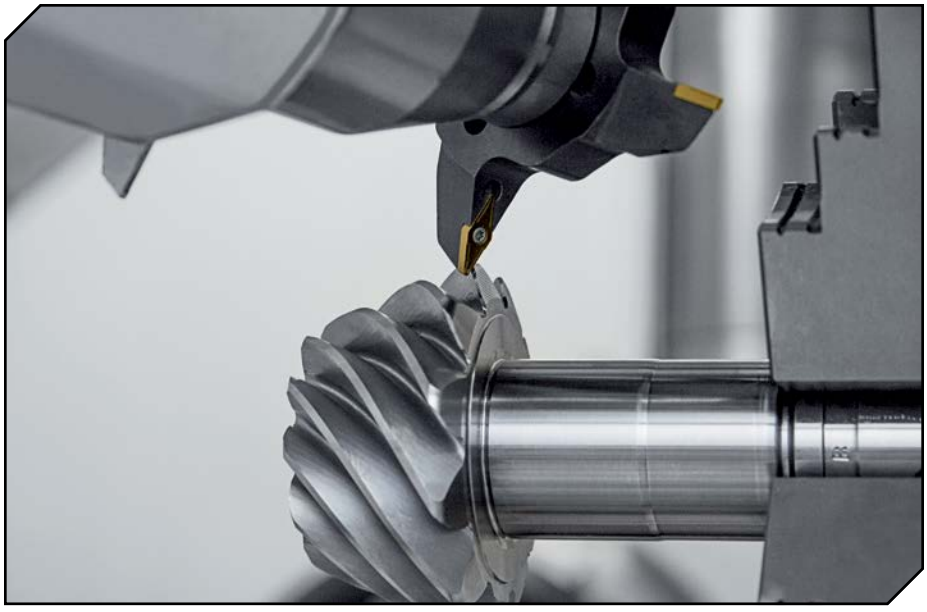
Chamfering by Fly Cutting is a continuous cutting process with a timed relationship between the tool and workpiece rotation, employing a contouring strategy to follow curved tooth edge geometries with a generic cutting tool and would be the choice for cutting chamfer when looking for small batches and flexible lot production. The coordinated motions of the chamfer unit axes allow the cutting tool to generate a chamfer along the workpiece edge contour. The chamfer tool has a star shaped body, with two to four replaceable, indexable standard inserts. Depending on the cutting strategy secondary burr removal processes with discs or inserts can be considered.

Ideally, one or two tool sizes fit most workpieces, therefore this process can be considered highly flexible. While fly cutting has been long employed on bevel gears, it has been just recently adapted as a viable chamfering process for cylindrical gears, one perfect example is the new Gleason 400HCD Hobbing Machine. Integrated into the machine on a separate station, the fly cutting process can be performed completely time-parallel to the hobbing process. Similar to chamfer-hobbing upper and lower gear edges

Machine Gleason Genesis 400HCD with rotary chamfering/deburring on a separate station allowing for time-parallel hobbing and chamfering/deburring.

are chamfered sequentially. Due to the required cutting time fly cutting is especially beneficial for medium to large sized gears so chamfering can be done during the hobbing cycle without jeopardizing productivity of the complete system.

A very flexible way of chamfering is offered by **chamfer milling employing endmills** typically made out of carbide. This is a very universal method since workpiece-specific tools are not required and fitting endmills can be ordered as commodity tools. Endmills can either be mounted on a swinging arm and the contact pressure defines the chamfer size or sit on a NC controlled tool carrier which follows the teeth edges. Especially with the milling tools on swinging arms the flexibility is higher prioritized than a tolerated and defined chamfer. Due to the duration of this chamfering/deburring process its strength is more in small or medium batch production and in the manufacture of larger gears. In most cases these technologies are performed on stand-alone machines when supporting dedicated gear cutting machines.



Autopath chamfering on a Gleason Phoenix 280CX, chamfer-cutting a bevel pinion.

Conclusion

Chamfering/deburring is an interesting example of a necessary but unloved process often proclaimed dead, that has been resurrected. One that is approached with expensive ideas, but is coming back strongly, especially in cases where honing as a finishing process is required. When large quantities of smaller gears have to be manufactured efficiently (minimum cost and within tight tolerances), rotary chamfering combined with one- or two-cut cycles or cutting chamfer is the method of choice. If modules larger than 5.0 mm have to be chamfered and deburred, cutting chamfer has been a viable solution. The "new" fly cutting process, borrowed from its bevel gear relatives, has further enhanced this quite costly process by adding flexibility to the cutting chamfer process while maintaining efficiency with considerably lower tool costs and even easier handling. More flexible methods exist, for example, chamfer grinding or chamfer milling, but they lack the productivity and tolerances of the previously-mentioned processes.

Chamfering/deburring with rotary tools or cutting tools and endmills for larger applications will address most challenges customers face today. We are excited to show our ideas at AMB in Stuttgart, IMTS in Chicago and Jimtof in Japan.

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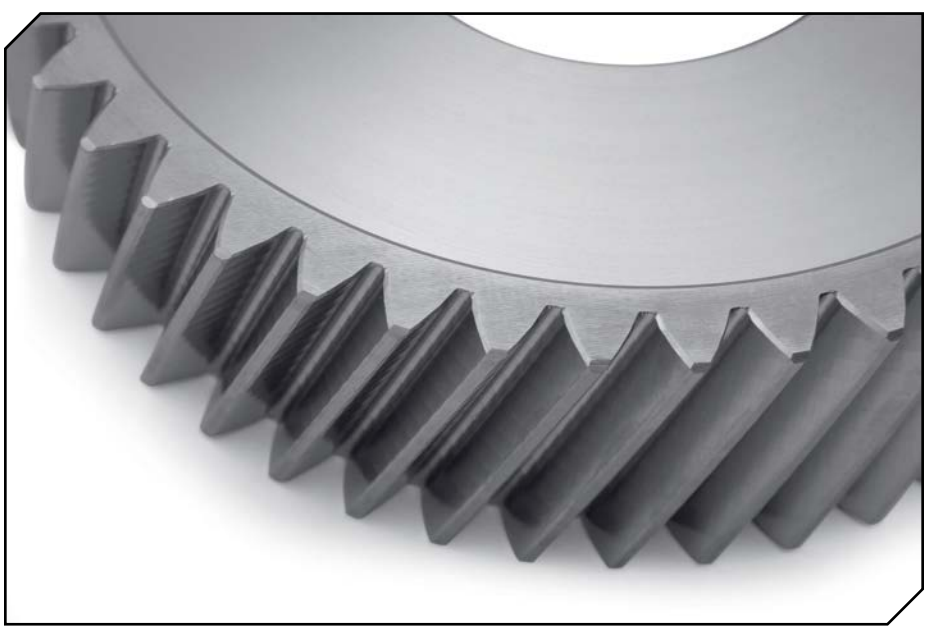

Cylindrical gear with defined chamfer, hobbed and fly-cut.

Gottfried Klein is director of product development hobbing and chamfering/deburring with Gleason Corporation.

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Updating Modern Production Processes

Liebherr Touts Automotive Technology in 2016

Matthew Jaster, Senior Editor

AGMA's Fall Technical Meeting (October 2-4, Pittsburgh, PA) will once again provide a noteworthy platform for sharing the latest technology on gear design, analysis, manufacturing and the application of gear drives and related products.

Dr. Andreas Mehr, technology development, gear grinding and shaping, at Liebherr, will be presenting his paper "Efficient Hard Finishing of Asymmetric Tooth Profiles and Topological Modifications by Generating Grinding," during the event. This paper will examine new possibilities of modifications with the continuous generating grinding method including deviation-free topological grinding (DFT), generated end relief (GER), noise excitation optimization (NEO), as well as the hard finishing of asymmetric gears.

Gear Technology recently caught up with **Scott Yoders**, vice president of sales, Liebherr Gear Technology, Inc., to preview some of these new advancements, reaffirm some tried and true gear manufacturing methods from Liebherr and discuss the company's role in the automotive industry moving forward.

Gear Technology (GT): Briefly explain some of Liebherr's latest grinding technologies and how they are being applied to the automotive industry?

SY: When making X-axis movements during generating-grinding — such as lead-crowning — you induce a sometimes unwanted "twist" into the tooth profile. To counteract that phenomenon, years ago (1987 in fact) Liebherr invented twist-free grinding, using the diagonal grinding method with a pressure-angle corrected tool, which can be applied to any automotive gear applications with lead crowning. (By the way, almost ALL automotive planets nowadays have lead crown.) When modern corundum tools for generating- grinding became the standard in industry, Liebherr updated this pressure-angle corrected software for use in high volume *dressable* applications with twist-free. With Liebherr's leadership in the field of twist-free grinding, we were recently able to build on this experience and introduce "deviation-free topological" or DFT grinding for the twist-free method. From our experience with customers, it was known whenever you grind twist-free, you sometimes lose microns on the profile crown. Early on, our customers had to use a special dresser design to correct the profile crowning that was lost during twist-free grinding. On a side note, this is something that our competitors will run into once they start really getting into this twist-free grinding. They will have to utilize a special dresser in most cases. But now from Liebherr — with DFT grinding — we can use *standard* dressing tools and simple programming corrections to give the customer what they want, a truly "deviation-free" untwisted part.

GT: Was this process then adapted and applied to generated end relief (GER)?

SY: Yes. That was the next step with DFT grinding from Liebherr. End-relief is well known in the gear industry. Take a helical gear, for example, if you put an end relief on the tip and root on opposite flanks you can increase the load carrying capacity of the gear, with an even thinner face-width. This is well known in big industrial gear applications (such as the wind energy market). End-relief corrections like this have always been possible in profile grinding, but it is performed one tooth at a time for big gears and the method was always too slow for automotive applications. The idea was to bring these end relief corrections to modern high volume generating grinding. When we introduced DFT grinding, we had the additional idea to pioneer what we call Generated End Relief — or, GER. It's working very well currently with some of Liebherr's automotive customers. We began our first tests in 2015 and it's providing great results in 2016.

Liebherr offers the LCS and LGG series for hard fine machining of gear wheels and splined shafts with an optimum machine concept.

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GT: What's going on regarding asymmetric gears in the automotive industry?

SY: It's coming. There will soon be a very large demand for these with our automotive customers. It's not new at all to tractor manufacturers. Liebherr machines have been up and running in production with tractor manufacturers for some time now. This is for gears designed for turning in one direction only, like we see in automotive planetary gearboxes (where there are clearly defined "drive" and "coast" flanks). Here we have a drive flank and coast flank, and the designer can optimize the pressure angle on the left to right flank and increase load carrying capacity. Again, this is well known in gear manufacturing, but we've applied it to modern generating grinding. The math is highly complex.

GT: You discussed noise excitation optimized modification with *Gear Technology* last year, what's the latest news regarding this?

SY: This is a process introduced by Liebherr for topologically grinding-on a specific wavelength and amplitude on the tooth flanks in both the profile and lead direction. Typically, you don't want waviness, you ideally want a straight line or ZERO for the ffa and ffB values. But here we're grinding specific ffa and ffB values into the part — on purpose — as a sort-of noise canceling feature. We're well aware of our automotive customers asking us to decrease gear noise and we've developed the mathematics to make this work in the continuous generating grinding process, together with the FZG in Munich. We're excited about the possibilities and this will be shown in-depth during the FTM in Pittsburgh. We look forward to discussing it more in detail with attendees this fall.

GT: Any other technologies or machine tool advancements that your automotive customers seem particularly interested in today?

SY: Even though our ChamferCut process in hobbing was introduced back in 2005, I recently saw several attendees at a trade show in Mexico interested in the product. We have all of these new technologies and gear developments and sometimes, it's an older product that people may have missed that gets the most attention.

We developed the ChamferCut with Fette and now it can be done in parallel — simultaneously — with the hobbing process which means the chamfering time comes along for free. This is burr-free chamfering and you don't need a second cut. Everything else in the market (roll press deburring, for example) is not really a true cutting process. This is specifically suited for automotive, but we see interest in aerospace as well as the truck market.

GT: What is Liebherr's role in developing and improving grinding technologies specifically for the gear market?

SY: You want to be careful when you hear about new and noteworthy advancements in the gear indus-

Machine demonstrations on the LGG 280 will be available during IMTS 2016 in Chicago from September 12-17.

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try today. It's important to do a little research. Twist-free grinding is a great example of this. Liebherr patented twist-free grinding way back in 1987 courtesy of Dr. Gerd Sulzer. This is nothing new from Liebherr, but there are others in the market saying it *is* new today.

During twist-free grinding the pressure angle (and therefore the resultant workpiece profile) is continuously changed along the entire worm length. The process uses the diagonal method (this has no impact on cycle time, but tool life is slightly reduced with corundum worms). The natural twist is eliminated.

Additionally, Liebherr invented the polishing of gear flanks during generating grinding back in 1988. This was applied with updated polishing abrasives for modern production processes with corundum some years ago. Some companies are showing this technology that Dr. Sulzer invented as absolutely new which is not really the case.

GT: There has been much discussion recently on the reliability and repeatability of one-table solutions in the gear industry. Where does this fit in with your automotive customer base?

SY: Naturally there is a higher process capability with a single table than with two. This is inherently from one single stream of process variation in the data. As automotive manufacturers and suppliers are noticing a reduction in tolerances for all gear features, this higher process capability is not a wish, but rather — more and more — a requirement.

It is also our thinking that the machine has less idle time for changeovers, less durable tooling (i.e., less fixtures needed) when a machine is producing multiple part numbers, and less process instability due to fixture wear issues and less mechanical movement. Much like the KISS method — we believe in simplicity of design at Liebherr.

GT: Finally, what can we expect from Liebherr at IMTS in Chicago this fall?

SY: We look forward to having discussions on all the technologies we've recently developed with our gear customers at IMTS. We also look forward to demonstrating the capabilities of our LGG 280 gear grinding machine and Wenzel's WGT 280 gear inspection machine. (*Editor's Note: For further information, check out Liebherr's IMTS Booth Preview on page* 64).

For more information:
Liebherr Gear Technology, Inc.
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IMTS 2016: Economic Elixir?

Jack McGuinn, Senior Editor

> "IMTS could be a good shot in the arm for everyone… overall, our analysts anticipate a good finish to 2016 and an even stronger 2017."
>
> — **Peter Eelman,** vice president, exhibitions, business development, International Manufacturing Technology Show

Peter Eelman *has been involved with the International Manufacturing Technology Show for more than 30 years. First as an exhibitor with Warner & Swasey Co.; later with Toyoda USA; later still as a consultant; and currently as vice president for exhibitions and business development, IMTS. He also serves on the board of directors of the exhibitor-appointed Contractor Association and is a former member of the board of directors for the Trade Show Exhibitors Association. Eelman is a speaker with the International Association of Exhibitions and Events and serves on the Metropolitan Chicago Pier & Exposition Authority Labor Council. As the head of IMTS, Eelman is the go-to, make-things-happen guy for the Chicago Convention and Tourism Bureau, the Metropolitan Pier and Exposition Authority, McCormick Place and the various vendors, service providers and trade unions involved in the complex trade show process. In addition to IMTS, Eelman is also prominently involved in shows with an international presence.*

Peter Eelman graciously took time to answer some pre-show questions for us.

Gear Technology (GT): Can you provide us with a brief history of the successful Hannover Fairs, USA synergy—especially the "Brought to You by" part?

Peter Eelman (PE): IMTS and Hannover Fairs began a partnership six years ago to bring certain elements of the Hannover Fair into IMTS. This effort has been extremely successful as Hannover Fairs now has five product pavilions—including Comvac North America; Industrial Automation North America; Industrial Supply North America; Motion, Drive & Automation North America; and Surface Technology North America. In the years since we began the partnership their participation has grown, from 20,000 SF at IMTS 2012 to 90,000 SF in 2016. What this has done for IMTS is continued to broaden the different types of manufacturing technology that visitors can expect to see. It really is the event to find the solutions you need, all in one place.

GT: Technology-wise, what would you say has been the most significant development in manufacturing since the 2014 show?

PE: The continued growth of digital manufacturing is having a major impact on our industry. This includes connected machines utilizing standards like MTConnect, to improved machine monitoring, to fostering things like predictive maintenance and improved utilization, to the ever-expanding world of 3-D printing. There is no doubt that digital manufacturing is reaching through all facets of the plant.

The continued advances in additive manufacturing, going from primarily a means of rapid prototyping to a part of regular production, has been incredible the last over two years. At IMTS 2016, for example, our partners from Oak Ridge National Laboratories will display a 3-D-printed house and car that integrate both renewable energy solutions and innovative manufacturing solutions.

GT: Care to weigh in on the health of U.S./Int'l manufacturing as IMTS 2016 kicks off?

PE: IMTS could be a good shot in the arm for everyone. The U.S. manufacturing technology market has been on a modest decline for about the last 18 months, and even the stronger automotive and aerospace industries have been slowing their orders. We've also seen weakness in the markets in Europe, China, and Brazil. Brexit is going to be a market disturbance that will have a global impact, though we expect that the markets will eventually adjust.

Overall, our analysts anticipate a good finish to 2016 and an even stronger 2017. There are some market trends that bode well for a turnaround kicked off by IMTS, including some announcements for big automotive projects, and increased activity for the F35 joint strike fighter program. Internationally, India is seeing a lot of growth in its manufacturing sector, and the Chinese and Brazilian aerospace sectors are heating up as well.

GT: Please speak to the importance of the international support for the show.

PE: IMTS has taken its place as one of the most significant international manufacturing technology events worldwide. The show continues to attract visitors from over 100 countries and our partnership with Hannover Fairs has expanded the international exhibitor base.

AMT—the Association for Manufacturing Technology—and

sponsors of IMTS, has a strong international presence in China, India, Brazil, Mexico, and Eastern Euro We have a number of international experts on our staff with extensive networks and connections in the markets they serve. This has helped to expand the international presence at IMTS, both among exhibitors and attendees. All of this is extremely important from the standpoint of building global collaborations throughout the industry, which are crucial not just from a business standpoint but also for discovering and developing new and innovative technologies. Manufacturing is a global industry, and IMTS is an ideal stage for showing that to the world.

GT: Looking at the big picture, how important are the educational programs being presented at the show? To what extent do exhibitors take part?

PE: With an event as exciting as IMTS, it's really important to leverage its appeal to students. This is an up-close introduction to all the possibilities in manufacturing careers. To that end, we are once again holding the Smartforce Student Summit, an interactive, hands-on event aimed at informing students, parents and teachers about the opportunities in manufacturing. This year's summit is centered on an aerospace theme and will feature several student challenges which will utilize technologies like 3-D printing, CAD/CAM, metrology, and robotics. Students can also take part in challenges for welding and machine building.

In addition to the exhibitors in the Student Summit, we are also introducing the Career Launch Pad, a career fair aimed at recent and soon-to-be graduates looking for employment in advanced manufacturing. Companies can post their positions in advance of the event to be matched with potential candidates. Students can upload their resumes when they register for the summit.

GT: What excites you most about this year's show?

PE: Every IMTS showcases the newest manufacturing technology from around the world. We are beginning to hear from our exhibitors about significant new product introductions that will have a dramatic impact on the way things are manufactured. It's always new and exciting, whether this is your first time attending or your 20th time. You can keep up with all the details on ***IMTS.com*** — the best place to check out all the features and attractions at the show.

GT: The industry focus within each co-located show — can we assume those are the most rewarding areas in manufacturing today?

PE: IMTS is made up of 10 pavilions in addition to the Hannover Fairs co-located shows. Each of those pavilions represents an important area of manufacturing and indeed IMTS 2016 will feature the debut of the additive manufacturing pavilion, an indication that additive manufacturing has arrived as a main-

stream industrial technology. Additive joins our other existing pavilions: Abrasive Machining/Sawing/Finishing; Controls & CAD-CAM; EDM; Gear Generation; Machine Components/Cleaning/Environmental; Metal Cutting; Fabrication & Lasers; Quality Assurance; and Tooling & Workholding Systems.

GT: IMTS began with one show, and is now up to five under one roof. Can it get bigger any time soon?

PE: IMTS evolves as technology evolves. As some technologies become more prominent, others become less prominent. IMTS flexes as the industry demands.

GT: Has security or personal safety ever been an issue around McCormick Place?

PE: McCormick Place has undergone a complete security audit with the Department of Homeland Security within the last year. As a result of that, several changes have been made to ensure the safety and security of the venue. Cooperation between show management and McCormick Place has never been better in the area of security. As always, IMTS show management continues to remain vigilant and cooperative with local authorities to ensure a safe and successful IMTS.

GT: Crystal ball time: this year's show—bigger than 2014?

PE: At this time, the show is projected to be larger in square footage, and attendance is tracking above our attendance in 2014.

IMTS 2016: IF YOU GO

IMTS 2016—International Manufacturing Technology Show (and GUESTS)

Six parallel trade exhibitions showcasing the Western World's largest, latest and greatest array of industrial and manufacturing technology. The bi-annual fair attracts more than 2,000 exhibitors and 110,000 attendees, i.e.—potential sellers and buyers.

The International Manufacturing Technology Show (IMTS)

- Industrial Automation North America
- Industrial Supply North America
- ComVac North America
- Motion, Drive & Automation North America
- Surface Technology North America

September 12th–17th, 2016
Chicago, Illinois McCormick Place

THE SIX CO-LOCATED SHOWS

International Manufacturing Technology

Over 2,000 exhibitors from the metalworking industry will display their products and productivity solutions.

Manufacturers will display their equipment in these product category pavilions:

- ***Metal Cutting.*** Contains everything from machining centers and assembly automation to flexible manufacturing systems and lathes.
- ***Tooling & Workholding Systems.*** Features jigs, fixtures, cut-

ting tools of all types and related accessories.
- ***Fabricating/Laser /Additive.*** Home to waterjet, plasma-arc and laser systems, welding equipment, heat treating, additive and more.

Industrial Automation

The best in industrial automation solutions will be featured at Industrial Automation North America, a show that made its North American debut in 2012. Featuring factory, process, and building automation, this event is distinguishing itself as the place to see the automation industry's most innovative solutions and technologies.

Motion, Drive & Automation North America at IMTS

The inaugural Motion Drive & Automation North America became a networking hub of North America's power transmission, motion control and fluid technology sectors. Meet face-to-face with key suppliers from around the world and see first-hand the best new technology available.

Surface Technology North America at IMTS

This event will cover the entire spectrum of industrial surface treatment and finishing — from cleaning and pre-treatment to coatings, paint finishes, and electroplating. Surface Technology will surely provide a powerful platform for business development and expanding professional networks.

ComVac North America at IMTS

Highlighting the latest product developments, technology, and plant & system components for all areas of compressed air and vacuum, ComVac will surely provide a powerful platform for business development and create a strong synergy with the already well-established Industrial Automation North America and Motion, Drive & Automation North America.

Industrial Supply North America at IMTS

Industrial Supply North America will cover the entire spectrum of industrial subcontracting and lightweight construction. This is the event where you will find supply solutions across the entire industrial value chain.

ADDITIONAL EVENTS OF INTEREST

2016 Global Automation and Manufacturing Summit

Wednesday, September 14th, 2016
Room W196-C

The fourth industrial revolution is in full swing, bringing about swift changes to the manufacturing environment. The Internet of Things is setting new standards but at the same time creating new problems to solve. Hear from experts on adapting to this new age of industry and participate in panel discussions that will provide insight on topics such as robotics, big data, and cloud-based manufacturing.

- 11:00 am–Registration open
- 12:00 pm–12:30 pm - Lunch - Sponsored by ATS
- 12:30 pm–1:15 pm - Keynote
  Jack Nehlig, president and CEO of Phoenix Contact USA, will discuss his company's initiatives on the Industrial Internet of Things — both as industry supplier and manufacturer.

- 1:30 pm–2:30 pm - Cloud-Based Manufacturing: Who Will Rule the Clouds?
  An overview of industry attitudes toward an adoption of IIoT in manufacturing, followed by a panel discussion with Denis Cambruzzi from IHS and Rob McGreevey from Schneider Electric.
- 2:30 pm–3:30 pm - Robotics: Rise of the Machines
  An industry overview on the adoption and use of robotics in manufacturing will be provided by representatives from the Control System Integrators Association (CSIA), followed by a panel discussion led by Rick Vanden Boom of Applied Manufacturing Technologies.
- 3:30 pm–3:45 pm - Break
- 3:45 pm–4:30 pm - How Maintenance and Big Data Can Co-Exist Sal Speda of ARC Advisory Group will provide the framework for the panel discussion on maintenance in the age of IIoT, which will include Franz Gruber, founder and CEO of FORCAM, Aurelio Banda, president and CEO for North America of Beckhoff Automation, and Chris Lebeau, IT Director of Advanced Technology Services (ATS).
- 4:30 pm–6:30 pm - Reception and networking event: Sponsored by FORCAM

* For conference pricing — go to ***IMTS.com***

2016 Integrated Industries Conference

Tuesday, September 13th, 2016

This first-time event, the Integrated Industries Conference, will bring together industry experts with the goal of addressing solutions to current manufacturing concerns, sharing new trends and best practices, and ultimately helping companies thrive in today's dynamic manufacturing environment.

This conference will synergize closely with technology on the show floor, and feature topics such as Motion, Drive & Automation, Surface Technology, The Internet of Things, and Industry 4.0.

- Track A: Motion, Drive & Automation — Room W196-A
- Track B: Industry 4.0/Internet of Things — Room W196-C
- Track C: Surface Technology — Room W196-B

TRACK A – MOTION, DRIVE & AUTOMATION

- 8:00 am–8:55 am - Registration
- 9:00 am–9:55 am - "Miniature Low-Vibration High-Pressure Air Compressor" Olly Dmitriev, CEO — Vert Rotors
- 10:00 am–10:55 am - "Total Cost of Ownership: Electric Actuators vs. Pneumatic Cylinders" Aaron Dietrich, Director of Marketing — Tolomatic
- 11:00 am–11:55 am - "Increase Production with Machine Safety" Joaquin Ocampo, Product Manager — Bosch Rexroth
- 12:00pm–1:10pm - Lunch Break
- 1:15 pm–2:10 pm - "Reduction of Common Mode Noise to Almost Zero Using High-Performance All-Pole Sine-Filters" Christoph Wesner, Head of Acc. Testlab/Standards & Approvals — Block Transformatoren-Elektronik
- 2:15 pm–3:10 pm - "Synchronous PM Linear Motor Motion Technology" Jean-Marie Rennetaud — Hiwin
- 3:15 pm–4:10 pm - "What is Beyond Universal? A Journey into Customizing Universal Joints" Maxine Gomez, Application Specialist – Belden Universal

TRACK B – Industry 4.0 / Internet of Things

- 8:00 am–8:55 am - Registration
- 9:00 am–9:55 am - "Taking a Doctor's Approach to

Automation" Jordan Merhib, Director of Business Development — Applied Manufacturing

- 10:00 am–10:55 am - "Where is Industry 4.0/IIoT Leanding Us, and More Importantly, for How Long? Why Should I Care?" Prof. Dr. Juergen Kletti, CEO — MPDV USA, Inc.
- 11:00 am–11:55 am - "How the Industry 4.0 Philosophy Brings Greater Flexibility, Faster Turnaround Times, and Lower Costs to Design and Production" Andrew Pritchard, Sales Director (Central Region) — Rittal
- 12:00 pm–1:10 pm - Lunch Break
- 1:15 pm–2:10 pm - Part 1: "On the Way to Industry 4.0 — Practical Solutions for the Middle Class from the German Technology-Network Intelligent Technical Systems Ost Westfalen Lippe (it's OWL)" Günter Korder, Managing Director – IT's OWL Clustermanagement GmbH
- Part 2: "Sustainable Approaches for the Implementation of New Production Technologies, Especially in Respect of Individualization, Virtualization, Hybridization and Self-Optimizing Production." Denis Özdemir, Managing Director, Cluster of Excellence Integrative Production Technology for High-Wage Countries — RWTH Aachen University
- 2:15 pm–3:10 pm - "The Future of Pneumatics: smart technology from Bimba Manufacturing that maximizes uptime with predictive intelligence and condition-based monitoring" Jeremy King, Product Marketing Manager – Bimba
- 3:15pm–4:10pm - "Innovations in Process Monitoring & Diagnostics" Bob Rice, Vice President of Engineering — Control Station

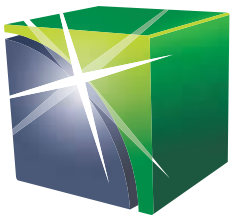
TRACK C – SURFACE TECHNOLOGY

- 8:00 am–8:55 am - Registration
- 9:00 am–9:55 am - "Powder Coating Spray and Recovery Technology Offers Greater Production Flexibility and Output" Jeffrey Hale, Director of Marketing — Gema USA
- 10:00 am–10:55 am - "Addressing Traditional Failure Modes in Combustion Engine Components" Bryce Anton, R&D Manager — Vapor Technologies, Inc.
- 11:00 am–11:55 am - "New Trends with Laser Texturing" Chad Hase, Laser Project Manager — GF Machining Solutions
- 12:00 pm–1:10 pm - Lunch Break
- 1:15 pm–2:10 pm - "Cleaning with Non-Halogenated Hydrocarbons in Comparison to Water-Based Cleaning" Sandro Siminovich, Product Line Manager (CLI) — Duerr Ecoclean
- 2:15 pm–3:10 pm - "CO2-Based Atmospheric Spray Cleaning and Surface Preparation: Technology, Applications, Equipment Configuration, and Operating Costs" Nelson Sorbo, Vice President of Research and Development — Cool Clean Technologies LLC
- 3:15 pm–4:10 pm - "Successful Implementation of an Aqueous Industrial Parts Cleaning System within a Manufacturing Facility" Ed Tulinski, Vice President & General Manager — Jenfab

For Related Articles Search
IMTS
at www.geartechnology.com

IMTS 2016
PRODUCT PREVIEW

The following exhibitors are suppliers of products or services that may be of interest to gear manufacturers who visit IMTS 2016. The Booth numbers include a letter indicating the building location (N=North, S=South, E=East, W=West, C=North Building, Hall C). **Exhibitors featured in advertisements or our booth previews (pages 50-73) are indicated by page number in the listings.**



IMTS2016
International Manufacturing Technology Show
September 12 - 17, 2016 · McCormick Place · Chicago

ALPHABETICAL LISTINGS			
COMPANY	Booth #	Booth Preview	Ad
Affolter Technologies SA	N-7223		
American Broach & Machine Company	N-7030		
Artis Systems, Div. of Marposs	E-5516, S-8719		66, 89
Blaser Swisslube	W-1238		
Bourn & Koch Inc.	N-6924	72	IFC-1
Breton SpA	S-9186		
Broach Masters/Universal Gear	N-7112	50	17
Broaching Machine Specialties Co.	N-7229		
Buderus Schleiftechnik	N-6762	54	
C.L.C. srl	N-6918	64	44
CleanParts.com	N-7234		
Cleveland Deburring Machine	N-6589		
CUMI America	N-7172		
Distech Systems known as Gleason Corporation	N-7000	59	48-49
DMG Mori	S-8900	50	
Doimak S.A.	N-6698	50	
Donje Industry Corporation Ltd.	N-6894		
Dontyne Gears Ltd.	N-7227	52	
Dr. Kaiser Diamantwerkzeuge GmbH & Co.	N-7240		
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DTR Corporation	N-7027	52	43
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Gleason-Hurth Tooling	N-7000	58	48-49
Gleason Metrology Systems Corporation	N-7000	58	48-49
Gleason-Pfauter Maschinenfabrik GmbH	N-7000	58	48-49
Gleason Plastic Gears	N-7000	60	48-49
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GMTA	N-6924	57	53
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Penta Gear Metrology LLC	N-7036	62	40
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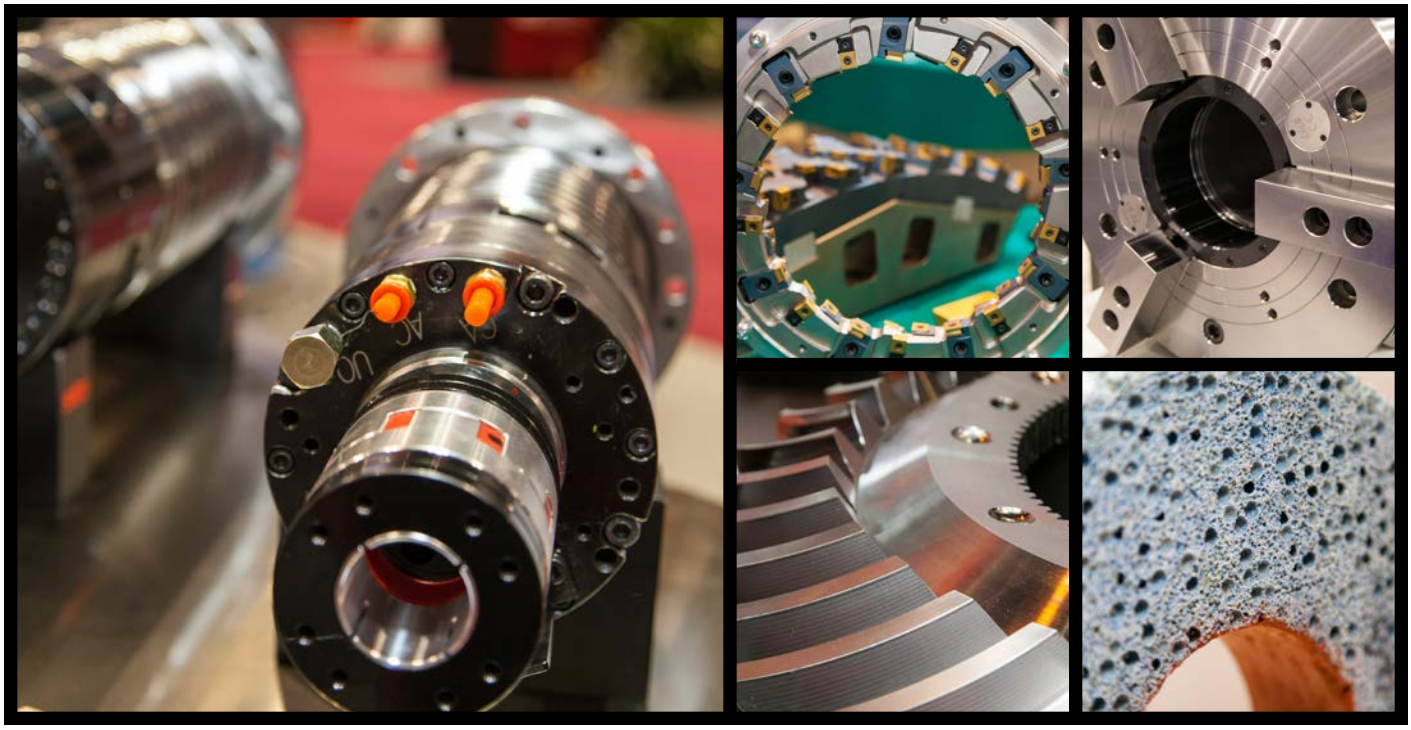
Zoller Inc	W-2022	73	



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Marposs	E-5516, S-8719	67	61, 89
Mahr Federal	E-5614	66	34, 51
Wenzel America	E-5622		
Solar Manufacturing	N-6358	71	36
Paulo	N-6373		
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Cleveland Deburring Machine	N-6589		
Galdabini	N-6598		
Doimak S.A.	N-6698	50	
Gehring L.P.	N-6740	57	59
Buderus Schleiftechnik	N-6762	54	
DVS Gruppe	N-6762	54	26
Pittler T&S GmbH	N-6762	54	26
Präwema Antriebstechnik GmbH	N-6762	54	
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Klingelnberg America	N-6827	63	Back Cover
Klingelnberg GmbH	N-6827	63	Back Cover
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Yager Gear Enterprise Co., Ltd.	N-6889		
Donje Industry Corporation Ltd.	N-6894		
C.L.C. srl	N-6918	64	44
Helios Gear Products	N-6918		
Koepfer America, LLC	N-6918	63	35, 44
Lambert + Wahli AG	N-6918		
Monnier + Zahner AG	N-6918	64	
Tyrolit GmbH & Co. KG	N-6918		
Bourn & Koch Inc.	N-6924	72	IFC-1
FFG Werke GmbH	N-6924	72	IFC-1
German Machine Tools of America	N-6924	57	53
GMTA	N-6924	57	53
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Modul	N-6924, S-8129		
Star Cutter Company	N-6924, W-2258	71	
Liebherr Gear Technology, Inc.	N-6930	64	5

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Gleason Automation Systems	N-7000	60	48-49
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Broach Masters/Universal Gear	N-7112	50	17
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Roto-Flo, including U.S. Gear Tools	N-7115		
Mecanica Comercial Meco, S.L.	N-7124		
Ty-Miles, Inc.	N-7127		
CUMI America	N-7172		
Fromag	N-7220		
Mitts & Merrill L.P.	N-7220		
Affolter Technologies SA	N-7223		
Dontyne Gears Ltd.	N-7227	52	
Broaching Machine Specialties Co.	N-7229		
Ekin S Coop	N-7229		
CleanParts.com	N-7234		
Dr. Kaiser Diamantwerkzeuge GmbH & Co.	N-7240		
Krebs & Riedel Diamantwerkzeugfabrik GmbH	N-7240		
S.L. Munson	N-7240		
Gear Technology Power Transmission Engineering	N-7324		
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Noritake Abrasives	N-7422		
Oelheld US	N-7475	68	34
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Mazak Corp.	S-8300		
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Mobil Industrial Lubricants	S-9292		
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Location: 5876 Sandy Hollow Road, Rockford, IL 61109
Inspection: Wednesday, September 14th from 9:00 AM - 4:00 PM CDT

FEATURING: 2003 **HOFLER** RAPID 1500 CNC Gear Grinder; 2007 **SAMPUTENSILI** G250 Gear Grinder; 2002 **SICMAT** RASO 200 5-Axis CNC Gear Shaver; **MITSUBISHI** FA30 CNC Gear Shaver; 1998 **HOFLER** HELIX 400 CNC Gear Grinder; 1997 **GLEASON** TAG 400 CNC Gear Grinder; 1994 **REISHAUER** RZ301AS CNC Gear Grinder; **REISHAUER** RZ300E Gear Grinder; **LIEBHERR** L652 CNC Gear Hobber, Retrofit 2005; 1993 **MITSUBISHI** GC 40 CNC Gear Hobber; (2) 2011 & 2009 **CHONGQING** CMT YKB3189 CNC Gear Hobbers; (2) 2011 **CMTM** Y3150 CNC Gear Hobbers; **PFAUTER** P900 Gear Hobber; **GLEASON** 1000 GMM SIGMA 10 Gear Inspection System; Various **BARBER COLMAN** Hobbers; **FELLOWS** Gear Shapers; Rotary Grinders; Turret Lathes; CNC Machine Tools; Keyseaters; Bandsaws; Surface Grinders; Perishable Tooling Specific to the Gear Industry; Factory Support Equipment; Forklifts; Free Standing Crane Systems; Air Compressors & Dryers; etc.

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IMTS2016
Booth N-7000

Total Gear Solutions **Gleason**

IMTS 2016 Booth Previews

Our guide to the gear stuff

The Broach Masters Inc.

N-7112

Broach Masters is a manufacturer of broaches, disc shaper cutters, shank shaper cutters, gear shaper cutters, spline broaches, master gears, spline gauges and other cutting tools, made in the USA.

For more information:
The Broach Masters Inc.
Phone: (530) 885-1939
www.broachmasters.com

DMG MORI

S-8900

This year at IMTS, DMG MORI will be showcasing automation capabilities, especially in the field of gear manufacturing. DMG MORI will display, among others, the NLX 2500 SY, a universal lathe factory installed with a gantry loader, the DMU 40 eVo linear and the DMC 125 FD duoBLOCK.

NLX 2500 SY 3-Axis Lathe

The 3-axis lathe NLX 2500 SY with gear machining techniques such as hobbing and broaching will be demonstrated at IMTS. With rigid machine construction and a direct-drive motor in the turret, the NLX 2500 SY is well equipped for such applications. The factory installed gantry loader as well as the second spindle enables an autonomous production and six-side complete machining of high-volume shaft components with gears and splines. The gantry can also be applied to many other types of DMG MORI lathes and even to multi-tasking machines, such as DMG MORI's CTX gamma 2000 TC 2nd Generation.

Pictured: NLX 2000SY

DMU 40 eVo Linear Machine

Aside from demonstrating hobbing and broaching, DMG MORI is demonstrating power skiving on the DMU 40 eVo *linear* machine, its universal 5-axis machining center. This one can also be equipped with various automation solutions like the WH 10 and WH 25 part handlings or differently sized pallet handlings. The DMU 40 eVo *linear* will be turning an ID bore and then power skiving an internal gear. Power skiving for larger gears will be demonstrated on a DMU 125 FD duoBLOCK.

At IMTS the DMU 40 eVo *linear* and NLX 2500 SY will demonstrate complete machining of the pre-heat treat operations of the part. Both machines are capable of turning, keyway milling, gear machining, hole drilling and other operations. They are also suitable for the unattended operation by adding various types of gaging and inspection capabilities in the cell.

DMG MORI is taking a solutions approach in providing the customer with not just a high-technology machine but a complete automation solution with integrated systems. DMG MORI's in-house team of automation experts can support all automation needs of its customers.

Apart from these high-volume gear production machines, DMG MORI will also have their line of multi-tasking machines producing gears using other gear manufacturing methods. DMG MORI will also feature their additive-subtractive hybrid machine, LASERTEC 65 3D.

For more information:
DMG MORI
Phone: (847) 593-5400
www.dmgmori.com

Doimak North America

N-6698

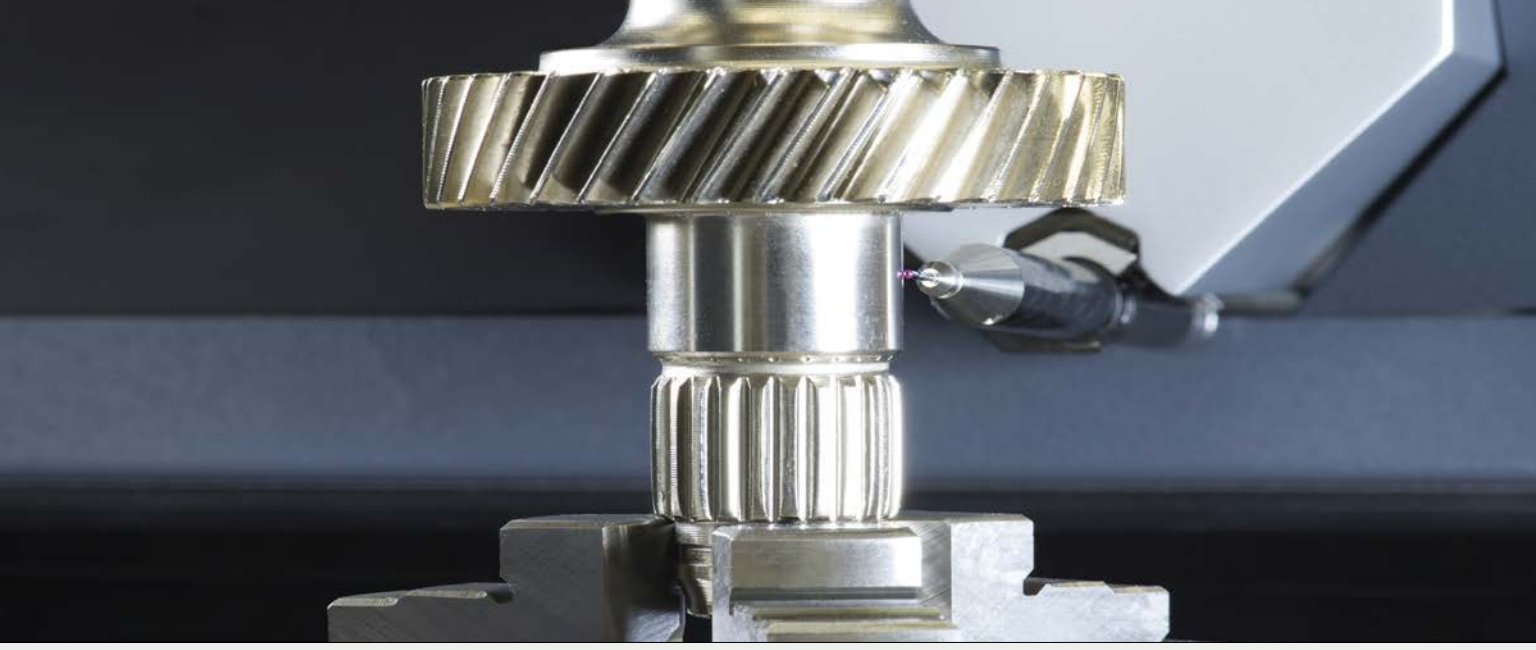
RER-G Combi 500 Grinding Center

Doimak will display the RER-G Combi 500 Grinding Center with Fanuc CNC and two wheelheads. Designed for grinding OD, ID and threads, the RER-G is equipped with a fast automatic changing grinding head by means of a rotary base turret, enabling multiple grinding operations in a single setup. The RER series offers a compact design, external/internal thread grinding in fully automatic transition, OD and gear grinding with optional CBN or peeling and b axis for tapers, flexible multi-task grinding, 2-axis contour dress or full form. The machine is available in a two- or three-wheel head design.

Additionally, Doimak recently delivered two REN-T spline and gear grinding machines for the machining of cycloid, helical and spur gears. Doimak tested and delivered these models that included integrated probing technology for gear inspection. The machine inspects gear diameter, run-out or teeth alignment just after grinding takes place, reducing machine setup times and providing a more efficient overall machining process thanks to the integrated inspection technology. The following is a brief rundown of some of Doimak's other machining capabilities:

Thread Grinding

Thread grinding machines for all types of threading technology are the product line most representative of Doimak. The latest CNC technology is implemented with built-in drives and linear motors. These machines include a wide range of spindle designs offering optimum stiff-



GEAR MEASUREMENT… EXACTLY

Mahr's Class 1 Universal Gear Testers provide fast, accurate analysis for a wide range of gear and gear tool applications on gears with OD's up to 600 mm (23.6 in). The GMX systems incorporate a high-accuracy scanning probe head, automatic tailstock and powerful controller to make them an excellent solution for both universal and specialized gear manufacturing processes. They also feature ultra-high precision spindles, originally used in the renowned Mahr Formtester series, to allow very accurate form measurements to be made as well. Equipped for both stand-alone shop floor and gear lab applications, Mahr's GMX systems can also be fully networked for fast and efficient transfer of measuring results and machine corrections.

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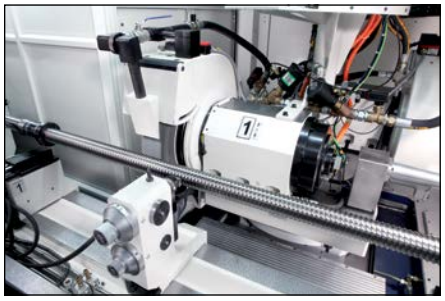
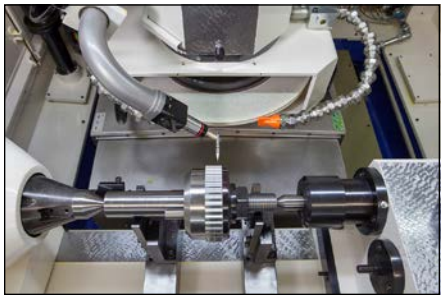
ness and damping response. Any type of profile can be dressed thanks to the flexible contour dresser, which also accommodates plunge forming rolls. Multi-ribbed wheels are used for improving process productivity and mass production machines are equipped with robot or gantry type loaders. They offer a higher degree of process automation thanks to different probing and component measuring solutions.



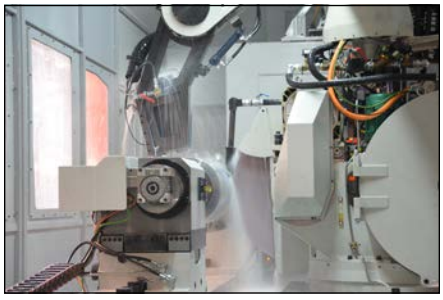
Cylindrical Grinding

Doimak provides solutions for a wide range of cylindrical shaft grinding applications including extrusion screws and barrels, power generation, printing and more. Different disposition of wheels, including OD/ID solutions with multiple grinding heads mounted in a single swiveling base are available for any type of application requirement.



Gear Grinding

Doimak has also developed several machining solutions for the gear and transmission field. Based on the RER thread grinding platform, straight and helical involute gears can be ground using latest CNC technology which includes built-in drives and linear motors. Involute, as well as cycloidal gear profiles, are automatically calculated according to standard gear parameters.



Automotive

Doimak provides in-process measuring gauges and high performance tools in order to optimize productivity. Mass production machines can be equipped with robots or gantry-type automatic loaders. In most cases, these machines are equipped with hydrostatic drives in order to avoid wear in moving components minimizing production stops due to maintenance requirements.

For more information:
Doimak North America
Phone: (317) 370-2975
www.doimak.com

Dontyne Gears

N-7227

Dontyne Gears uses modern technology to improve production and performance of gear systems, including Dontyne Systems software. New for IMTS 2016, Dontyne Systems has announced that its closed-loop gear manufacturing system now includes the ability to export directly to G-Code.

What this means, says Dontyne co-founder Dr. Michael Fish, is that the system can now export gear tooth cutting paths directly to Mazak machines (Booth #S-8300) without the need for intermediary CAD/CAM software.

Dontyne's closed-loop gear manufacturing system was described in depth in the July 2016 issue of *Gear Technology* (page 10).

In addition, visitors to the Dontyne booth can learn about the company's *Gear Production Suite*, a suite of tools for generating design and load analysis models as well as required tooling.

For more information:
Dontyne Gears
(859) 803-1191
djones@dontynesystems.com
www.dontynesystems.com

DTR Corporation

N-7027

Formerly known as Dragon Precision Tools, DTR Corporation will showcase their latest gear cutting tools. DTR has 40 years of experience in manufacturing cutting tools for gear production and specializes in customized hobs, shaper cutters, milling cutters, broaches and master gears, and some of their best samples will be exhibited at the show. DTR offers a complete line of coarse-pitch to fine-pitch tools serving various industries including automotive, aerospace, construction, mining and other equipment industries.

When processing an order, DTR starts by selecting the material based on their collected production data. For example, some customers may find production speed to be the most important factor for mass production, and a tool would need a higher grade material to make sure it can meet customer demands. DTR maintains an inventory of 300 tons of raw materials, which allows them to eliminate delays in production.

DTR's experienced design engineers can review provided gear drawings to make sure the cutter will produce an accurate tooth profile and meet the class requirement, and also maximize the tool life by assigning the right number of gashes for the tool size.

GMTA NOW REPRESENTING

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GERMAN MACHINE TOOLS OF AMERICA (GMTA) is now the authorized North American representative for **Rasoma**, a builder since 1919 of high-quality vertical turning centers, 4-axis shaft turning centers, end machining centers, double-spindle machining centers and a variety of automated solutions for the automotive and other industries.

The addition of **Rasoma** to our other lines makes **GMTA** a viable partner for nearly every application in the powertrain, gearmaking, bearing and other production line concepts for auto, motorcycle and off-road vehicles, as we bring full application engineering, machine building, laser integration and commissioning to your facility, with single-source support and service from our plants in Ann Arbor, Michigan and Queretaro, Mexico.

Take a look at **Rasoma** and all our lines at **www.gmtamerica.com**. You'll be glad you did.

IMTS2016
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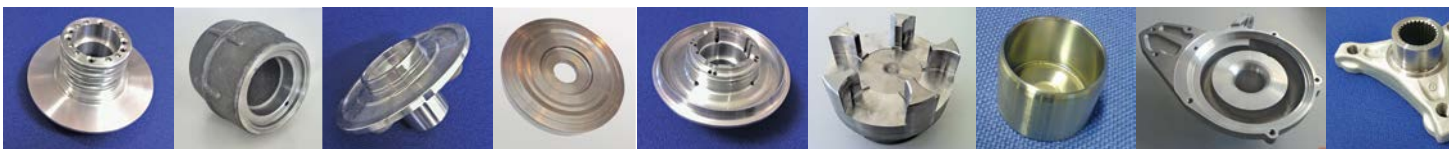

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GMTA
German Machine Tools of America

Ann Arbor, Michigan | Queretaro, Mexico | www.gmtamerica.com | Email: company@gmtamerica.com

Properly applying the coating and finishing with a smooth surface is another critical step for better tool life. DTR uses their own developed coating machine and surface finishing machine, which ensures the cutting tool has an even surface, which will help reduce the wear amount. Ensuring a smoother surface for cutters will also help reduce the cost of grinding tools for finishing. Lastly, it will help gears have a smoother surface which will contribute to less noise.

For more information:
DTR Corporation
Phone: +82 32-814-1540
www.dtrtool.com

DVS Technology Group

N-6762

Buderus Schleiftechnik UGrind Workshop Machine

Buderus Schleiftechnik will be presenting the new Buderus UGrind — a workshop machine designed for efficient and flexible hard finishing of small batches. The machine includes a multifunctional tool revolver for grinding, turning and measuring operations, as well as intuitive operating software with integrated processing and measuring cycles and automatic calculation of the most efficient process strategy.

Depending on the configuration required by the user, the Buderus UGrind carries out external and internal, face and cone surface grinding as well as hard turning operations. The integrated measuring probe controls and monitors machining until the required final dimension has been achieved, which means time-consuming processes such as successive feeding and re-measuring are no longer required.

Präwema Antriebstechnik Vario Cross Honing

Präwema Antriebstechnik GmbH will be presenting its latest innovation optimizing gearing surfaces — the Vario Cross Honing technology. By using a specially developed oscillation method during the honing process, Vario Cross Honing enables surface roughness to be reduced even further, resulting in another increase in the surface quality of geared components. This innovation allows gearing manufacturers to produce wear- and noise-reduced vehicle gearboxes with higher torque transmission.

Pittler PV315 Gear Cutter

Pittler T&S GmbH will be presenting the PV315, the latest addition to the PV3 family of machines for complete machining and has been specially adapted to the requirements of commercial vehicle components such as ring gears. Equipped with a multi-function head, Y-axis and tool magazine for up to 20 different machining tools, the PV315 turns, drills, grinds, mills, deburrs and machines internal and external gearing of the quality class IT6 using the efficient power skiving method. This results in a surface quality with an Rz value of less than 2 µm on the tooth flanks as well as a main time three times lower than if the shaping method were used. At the same time, tool costs are reduced since the versatile tool magazine of the Pittler PV315 provides a skiving tool for rough skiving first followed by a finishing skiving tool, thus significantly extending the service life of the higher quality finishing tool.

For more information:
DVS Technology Group
Phone: +49-69-24 00 08-68
www.dvs-technology.com

EMAG L.L.C.

N-6834

At this year's show, EMAG will present its family of turning centers, gear generation machines, grinding, milling, vertical turning and boring equipment, plus advanced electro-chemical and laser welding machines, as well as heat treatment. A variety of machines will be on display in the booth, running under power, plus they'll have experts in all the various technologies they offer, available for discussions. EMAG is a family of global machine companies that includes Eldec, Naxos-Union, Koepfer, Reinecker, Laser Tec, ECM, Kopp and Karstens. The company today often integrates a variety of machines into work cell arrangements at major automotive, off-highway and other power transmission component suppliers.

VL 4 Vertical Lathe

The VL 4 is a modular vertical lathe with integrated automation, designed for maximum production at low cost per piece with a small footprint. A pick-up spindle moves in the X- and Z-axes with 12 driven tools on a turret to cut and index parts up to 200 mm (7.87") in the shortest time possible. The pass-thru rotary conveyor keeps blanks incoming and machined parts outgoing. Machines can be equipped with a Y-axis for more complex geometries.

VM 9 Turning, Milling and Drilling Machine

The VM 9 combines turning, milling and drilling into a single machine for large part production. With the workpiece spindle in the bottom of the cutting theatre, the VM 9 offers a turning diameter of 450 mm (17.71"), max workpiece height of 300 mm (11.81") and max workpiece weight of 300 kg (660 lbs).

VT 2-4 Shaft Machine

The VT 2-4 performs dual-sided shaft machining in high-production mode with dual 11-position tool turrets for fixed or driven tools. Workpieces can be up to 200 mm in diameter (7.87") and 630 mm length (24.80").

Eldec MIND-M 250

The eldec MIND-M 250 is a compact hardening system for basic heat treatment of chucked parts and shafts, provided by the eldec group of EMAG. Heat treatment tasks are performed at 30kW in high frequency applications and 100kW in medium frequency. Workpieces to 10kg (22 lbs).

Other Products

The EMAG booth will also feature a blisk (bladed disk) display to demonstrate the Precision Electro-Chemical Machining (PECM) technology now offered to the aerospace, pump and power generation markets. In depth, technical videos will be shown at the booth to present some of the other technologies available at EMAG, including the laser welding technology.

For more information:
EMAG L.L.C.
Phone: (248) 477-7440
www.emag.com

Emuge Corp.

W-1536

FPC Mill/Drill Chucks

Emuge Corp., in partnership with Albrecht Precision Chucks, has introduced high precision/performance Emuge FPC Mill/Drill Chucks that provide increased rigidity, vibration dampening, concentricity, machining speed and tool life versus conventional chuck technologies for milling and drilling applications.

Featuring the world's only chuck with a 1:16 worm gear, Emuge FPC Chuck's design delivers three tons of traction force. The unique design and body provide 100 percent holding power for maximum rigidity, and the collet-cone assembly absorbs virtually all vibration for maximum dampening.

Unique features and advantages include an extremely high transferable torque that provides maximum process reliability (transferred torque on a tool shank diameter of 20 mm is 400 Nm); increased accuracy with a 3 × D tool length, concentricity is ≤ 3 µm to guarantee long tool life and quality work piece surface finishes; a chuck that is mechanical drive-actuated with a hex wrench, a simple design that enables quick tool change in seconds; a special holder design that reduces vibration, which dramatically improves workpiece surface finishes and provides exceptionally long tool life; and strong clamping force to prevent the possibility of pull-out.

FPC Chucks are designed to be the fastest on the market today. In a speed comparison with four chuck technologies, using a 20 mm end mill in the same material, the Emuge FPC Chuck enabled the feed rate to be increased by 30 percent with no loss in performance.

Emuge FPC Chucks are available in four shank styles (CAT, HSK-A, SK and BT) in 47 different sku's for a wide range of applications. A full range of high precision collets and accessories are also available for the FPC line. Emuge FPC Collets are available in three size ranges (FPC 14, FPC 20 and FPC 25) in over 35 different sku's, from ⅛" to 1¼" and in metric from 2 mm–32 mm.

For more information:
Emuge Corp.
Phone: (800) 323-3013
www.emuge.com

Euro-Tech Corp.

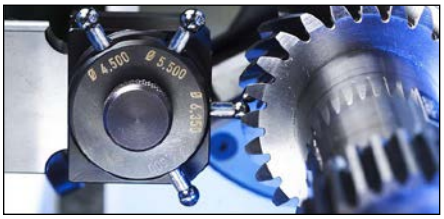
W-2453

Mytec Mechanical Arbors and Chucks

Euro-Tech Corporation's IMTS 2016 product lineup includes MyTec Hydraclamp expansion elements. Mytec is introducing its new line of Mechanical Arbors and Chucks with accuracy down to .0004" plus high expansion rates up to .010" or greater in a stainless steel construction. Mechanical arbors and chucks are excellent for workholding where high forces are incurred or auto load applications where high clearance is required. Mytec elements feature a closed expansion system, which is designed to be impervious to dirt and chips to guarantee a long service life.

Frenco Spline Gages

Euro-Tech's Frenco spline gage product line provides a quick method of inspecting involute splines, serration splines and straight sided splines to ensure interchangeability of parts even between different manufacturers. Frenco's INO System is an internal standard for the external dimensional measurement of spline gages developed based on national and international standards that is suited to even the most highly sensitive and complex components and systems.



Kostyrka Clamping Sleeves

Kostyrka slotted clamping sleeve technology is designed to create a shaft-hub joint actuated by hydraulic pressure to efficiently support the workholding function of modern machine tools which users can depend on for reliable operation day after day and year after year.

PG1000-400S-4K Cutting Tool Inspection Gage

Euro-Tech will be introducing the PG1000-400S-4K cutting tool inspection gage, adding true 4K inspection capability to their PG1000 product line with magnification to 400x and X-micron linear scales. 4K gives you visual resolution of at least four times more pixels than conventional 1080 pixel HD resolution, making it ideal for inspecting micro tools.

Tschorn 3D Tester

Euro-Tech is adding a new product line in 2016, the Tschorn 3D Tester. The Tschorn 3D Tester stands out with its robust structure and slim and attractive design. Its precise and versatile capabilities enable fast and easy calculation of workpiece reference points and lengths. Probing is possible in all axle directions (X/Y/Z) at the same indicator resolution. As soon as the indicator is at "0," the vertical axis is exactly on the edge of the work piece.

For more information:
Euro-Tech Corp.
Phone: (262) 781-6777
www.eurotechcorp.com

Foerster Instruments, Inc.

E-4501

Foerster testing systems can verify material properties and heat-treat conditions; detect cracks, chipped or missing teeth in the most intricate of manufactured gears.

Utilizing eddy current technology, Foerster manufactures non-destructive testing (NDT) equipment designed to be incorporated into your current production line.

For more information:
Foerster Instruments Inc.
Phone: (800) 635-0613
www.foerstergroup.com

Gehring L.P.

N-6740

Lifehone L630 Modular Honing Machine

Gehring L.P. has released the Lifehone L630 — the newest in its line of modular honing machines for precision metal components. Standard part applications that can be honed on the Lifehone range from sun gears to connecting rods, hydraulic sleeves and injector pump components.

The L630 has market-proven components in a modular design. Depending on customer requirements and the product spectrum to be finished, the machine is equipped with matching honing units. The Gehring honing control allows for precision controlled stroke speeds and reversal precision. An optional feature allows the stroke to be executed via a ball screw or a linear motor. The Gehring Operator Panel's (GOP) user friendly and clear graphic interface and the program assistant ease machine operation.

The L630 machine is a honing center that can be equipped with one or two honing spindles. Depending on the machining task and the batch size, this type of machine can be equipped with a fixed or rotary table and up to eight workstations. Stations can also be used for measuring or brushing operations. The single-spindle version of the Lifehone series has a compact design and small footprint — an advantage to customers with limited space or those who need to frequently change the type of part that needs to be honed.

Gehring will display the Lifehone L630 at IMTS this year, along with its entire portfolio of honing technologies and services, from position and form honing, laser structuring to contract honing and displays of its tooling & abrasives products. Gehring will hold daily technology briefings at Gehring's booth.

A technical presentation titled "Advanced Honing Technology Solutions for Modern Manufacturing" is scheduled for Thursday, September 15, 2016 at 11:00-12:00 in Room N-127 by Michael Schaefer.

For more information:
Gehring L.P.
Phone: (248) 478-8060
www.gehringlp.com

German Machine Tools of America (GMTA)

N-6924

Rasoma Milling, Hobbing and Shaping Machines

Now available from German Machine Tools of America (GMTA), a full line of Rasoma machining centers, including vertical turning centers, 4-axis shaft turning centers, end machining, double spindle and various special purpose machining centers with full automation.

Gear machines for milling, hobbing and shaping are available in a variety of configurations, and the GMTA application engineering team can assist interested parties to determine the best solution.

Rasoma machining centers offer high rigidity, due to separate X and Z slides, plus the machine head is designed as a monoblock with polymer concrete fill. Thermal stability is enhanced by cooled motor spindles, and the rapid traverse on these centers ranges up to 60m/min at high acceleration, with feed and removal speeds up to 120 m/min, less than six seconds from part to part and turret indexing typically under one second.

Full option packages include robotic handling and part articulation, integrated metrology onboard, working inside or outside the work envelope, full tool measurement and monitoring systems and driven tool packages, all controlled by a single Siemens CNC.

Samag Machining Centers

Now available from German Machine Tools of America (GMTA), a full line of Samag machining centers, including multi-spindle, horizontal machining centers, deep hole drilling machines and combination milling/drilling machines, is offered for the North American market.

Samag builds a variety of multi-spindle machines, including the MFZ Series for large workpieces, the smaller, modular WBM Series for up to six spindle deep drilling and the combination TFZ Series, which offers users the ability to bore and mill complex cubical workpieces on four sides with a single clamping. On the largest standard machine, large scale moldmaking is possible, with a maximum drilling depth of 2300 mm (over 90"), 65 mm (over 2½") bore and a 50-ton capacity work table.

The company also supplies complete turnkey operations, including robotic articulation, parts handlers and transfer mechanisms for high-production work such as connecting rods and complete machining of differential housings.

BvL YukonDAK Cleaning System

The BvL cleaning system is the continuous system "YukonDAK." It uses workpiece carriers to transport the goods on a chain conveyor. A light barrier ensures positioning accuracy for the exchange with the automation system.

The system carries out two steps: cleaning through spraying and drying through blowing. The items to be cleaned are crankshaft covers which are produced for a German automobile manufacturer. The parts are washed with a cycle time of 12 seconds and at a temperature between 50 and 55 °C.

The "exhaust air management" developed by BvL reduces the volume of exhaust air which consumes the most energy in a continuous cleaning system. To achieve this, the system measures the moisture content in the drying zone and extracts only as much air from the process as necessary. This creates the best possible moisture level in the system and the volume of hot exhaust air — and therefore energy — blown out of the system is kept as low as possible.

In addition to the energy saving measures, the cleaning system is equipped with a 50 µm dual changeover filter, an air-cooled steam condenser and a mist eliminator.

For more information:
German Machine Tools of America (GMTA)
Phone: (248) 921-0122
www.gmtamerica.com

Gleason Corporation

N-7000

Gleason will demonstrate brand new solutions in advanced gear manufacturing technology at IMTS 2016, covering a wide array of processes for the complete production and inspection of all types of bevel and cylindrical gears. Among the technologies to be exhibited are:

Genesis 260GX Threaded Wheel Grinder

The 200/260GX machines are the most recent addition to Gleason's Genesis machines series. The GX series features a two-spindle concept for maximum productivity with minimized idle and set up times. The 260GX applies the latest grinding process technology featuring twist control and polish grinding for mirror-like surfaces of workpieces. The easy software-guided setup of the machine allows operators to change from one workpiece to another within 20 minutes using only one tool. With the Gleason "First Part Cycle," operators actuate a fully automatic workflow from setup until grinding the first workpiece. Integrated automation made by Gleason, the ability to interface with Gleason GMS machines via QR code and excellent tooling solutions make this machine a comprehensive and worry-free solution from one source.

Hard Power Skiving

Witness Hard Power Skiving on the Gleason 300PS for the first time at IMTS. Gleason offers a tailored solution to your workpieces, including extraordinarily stiff machines, modular workholding and the right tools to meet the high requirements of the process. The Gleason Power Skiving Simulation Software depicts the cutting cycle for

every cut and ensures that cycle times are minimized and tool life is maximized.

500CB Cutter Build Inspection Machine

Another premiere is the 500CB, which is being shown for the first time outside the Gleason premises. The 500CB delivers more accurate and highly automated build, truing and inspection of all types of stick-blade bevel gear cutters with automated closed-loop blade positioning for better gear quality and maximum tool life. The 500CB also automatically controls the tightening of the blade clamp screws, consistently applying the correct torque without the previously required operator intervention.

Genesis 400HCD Gear Hobbing/ Chamfering and GEMS Software Package

The newest addition to the Genesis line of hobbing machines features a newly developed time-parallel chamfering process. With this new solution, customers will chamfer medium-sized gears more economically and with greater flexibility than ever before. Designed for dry hobbing, the 400HCD exploits the benefits of the latest cutting tools, employing high-speed spindles and a rigid structure. The 400HCD is equipped with the new Gleason Operator Software Package for easy and efficient operation of the machine, including many new features.

GMSL — Gleason Multi Sensor Metrology System

The brand-new GMSL series of machines offers the latest advancements in metrology systems within a compact and smart design. The new system features six axes of motion for gear and complex form measurement with options like integrated Barkhausen inspection capability and/or surface roughness measurement as well as new, full-form scanning capability. The ability to integrate multiple sensors on a common platform offers the capability of several machines in one system.

New Tool and Servicing Solutions

Gleason will present its complete gear manufacturing tool program, including modern tool servicing concepts with integrated connectivity via RFID. Products featured will include tool materials like G90 and advanced carbides, optimized with the latest wear coatings. Power Skiving Tools are now available in solid carbide and with inserted blades for the Hard Gear Power Skiving process. For bevel gears Gleason will show the Pentac Plus RT cutter head, which is designed to make blade setup and checking more reliable and faster than any current solution on the market. Gleason will also present its latest line of hard finishing tools including dressing tools for grinding and honing applications.

Advanced Workholding Solutions

Quik-Flex Plus, Gleason's next generation of modular, quick-change workholding systems requires a single tool, less time and minimal operator experience. Customers are invited to stop by and participate in the Gleason Quik-Flex Plus Challenge to experience how easy it is to change the modular components.

Gleason will also demonstrate its line

of hydraulic workholding solutions. The holding force, extreme accuracy and contamination-free designs are well suited for dry gear processing applications. The new Gleason Stir-Able Modular Workholding designs allow off-spindle assembly and truing, reducing change-over time as well as the amount of total run-out in the fixture.

Gleason Automation Systems with Modular, Integrated Solutions

Gleason Automation Systems specializes in the design and manufacture of factory automation systems serving a variety of customers in the automotive and other industries. Gleason will present the modularity of its automation systems with two different solutions including the compact DS1200 automation unit with integrated secondary processes as an accurate, reliable alternative to costly, operator dependent, conveyor automation. This compact system, which is compatible with most machine tools, uses robotic technology for loading and unloading. Its secondary operations capability allows this system to function as a versatile work cell, further enhancing productivity.

Gleason Global Services

Gleason Global Services is a leading source of gear technology knowhow and education. Gleason trainers will be promoting the full range of training classes ranging from beginner levels to the most advanced expert topics. Gleason Global Services will present its range of performance upgrades, modernization programs and tooling services, including practical examples.

Gleason Plastic Gears

Gleason Plastic Gears will showcase its capabilities in plastic gear design and injection molded plastic gears including bevel and cylindrical gears, helical and spur gears, planetary and internal gears. Gleason Plastic Gears provides customers with the benefit of a plastic gear with no weld-line for a stronger, more accurate and economical drive train, eliminating the additional expense of secondary machining. Our experts will be at the show to address all questions you may have.

For more information:
Gleason Corporation
Phone: (585) 473-1000
www.gleason.com

Hainbuch America Corp.

W-1636

Today — Tonight — Tomorrow Interactive Displays

Hainbuch America Corp. announced the shipment of the first wave of their TTT (Today — Tonight — Tomorrow) Interactive displays to machine tool distributors and OEMs, two of which will be showcased at Hainbuch's 2016 IMTS booth.

These TTT Interactive Displays are fitted with Hainbuch's standard products that are the formation of the Today — Tonight — Tomorrow modular system. To demonstrate the flexibility of the Hainbuch Modular System, the display is equipped with the Spanntop Nova chuck (the original 10-second collet chuck) for turning applications and the Manok plus chuck for stationary applications. The user can experience the simplicity and speed of going from O.D. clamping to I.D. clamping or to 3-jaw clamping in two minutes or less for each change-over. The adaptations included with the display are clamping heads (collets) for O.D. clamping, the Mando Adapt for I.D. clamping and the Jaw module for larger diameters.

The TTT Interactive Display will show end users how they can enhance the productivity and flexibility of their new machine, thereby improving OEEs and reducing the time it takes to recover their capital investment.

For more information:
Hainbuch America Corp.
Phone: (414) 358-9550
www.hainbuchamerica.com

Hardinge Inc.

S-8738

Hardinge Talent 51 MSY CNC Turning Center

The all-new Hardinge Talent 51 MSY CNC Turning Center will make its debut at IMTS. This machine features the Hardinge quick change Collet-Ready Spindle, which offers better part accuracy and surface finish capabilities as compared with conventional spindles. The machine also comes standard with live tooling, sub spindle and Y-axis designed to meet the most demanding machining challenges and allow for part-complete operations. The Talent 51 MSY features a 5,000 rpm 25HP main spindle with 2" bar capacity. It offers a turning diameter of 12.2" and a maximum turning length of 24.9". The 12 station turret uses ¾" square shank and 1¼" round shank tooling and 6000 rpm maximum live tooling capability is standard. The turret also provides ½ station index for up to 24 tools. The machine is offered with a Fanuc 0i-TF control packed with a host of standard control features.

Hardinge Conquest H51

The Hardinge Conquest H51 will be displayed with a newly released hydraulically-operated steady rest. This new attachment is the ideal tool to support long workpieces without distorting or deflecting the part. The machine features a 20hp, 5000rpm and a 2–6" main spindle with a 2" bar capacity. It offers a maximum turning diameter of 12.3" and a maximum turning length of 25.5". The 12 station turret offers ½ station index for up to 24 tools. The machine offers a wide variety of standard features such as through-tool coolant, bar feed and chip conveyor interfaces, three position stack light, PCMCIA memory card, USB Capability, rigid tapping and many others, including state-of-the-art machine crash protection.

Bridgeport XT 630 5-Axis Vertical Machining Center

On display for the first time is the new Bridgeport XT 630 5-Axis Vertical Machining Center. This new-generation machining center is a fully-digital, high-quality machine tool, designed to achieve maximum capacity and performance in the aerospace, mold and die, medical and automotive industries, as well as many other manufacturing sectors. This machine has been developed to meet the demands of the most demanding metal cutting user. Manufactured from quality sourced gray cast iron to the highest standards, the Bridgeport XT 630 5-Axis is packed with features. The machine is offered with a sophisticated yet user-friendly Siemens 840D-SL control with a 19" LCD. Axis travels are X: 762 mm (30") Y: 630 mm (24.8") and Z: 600 mm (24"). Standard machine equipment includes Big Plus CT40 spindle, 15,000 rpm direct-coupled spindle with oil chiller, coolant chip flush system, three color stack light, 40 tool swing-arm ATC, pre-wiring for Renishaw part probe, through-ball screw chiller, preparation for through spindle coolant (with a rotary union) and A & C axis encoder.

Additional Machines and Tooling

In addition, Hardinge will have on display the Bridgeport Conquest V480 APC Vertical Machining Center with integrated automatic pallet changer,

the Bridgeport Conquest V1000, the Kellenberge Varia Universal Cylindrical Grinding Machine, the Usach 100-T4 CNC Grinding Machine, Hardinge Quick-Change FlexC Collet Systems, Hardinge Sure-Grip Expanding Collet Systems and Hardinge Swiss-Style Collets and Guide Bushings.

For more information:
Hardinge Inc.
Phone: (800) 843-8801
www.hardinge.com

INDEX Corp.

S-8136

G220 Turn-Mill Center

The new INDEX G220 Turn-Mill Center includes a motorized 5-axis 18,000-rpm (max) milling spindle and a tool turret with Y-axis, providing maximum machining flexibility for turning and milling complex parts in a single setup from bar stock up to 90 mm diameter, chuck diameter 210 mm. Distance between spindles is 1280 mm, maximum turning length is 1000 mm. Users in the precision parts industries including automotive, aerospace, and mechanical engineering will benefit from the high-accuracy done-in-one capability of the machine.

INDEX will demonstrate the machine cutting bevel gears from bar stock at IMTS 2016. The cutting method is similar to the Klingelnberg gear generating method and makes use of the G220's Y-B axis provided in the milling head. According to INDEX, the process is ideal for smaller, 0.6 to 4 module, bevel gears as it can produce high quality gears — front and back — faster than conventional bevel gear machines. The G220 can also produce other type of gears as well as other complex precision parts due to its versatility.

The fluid-cooled, identical main and counter spindles provide power of 31.5/ 32 kW (100%/40%), a torque of 125/170 Nm and a maximum speed of 5000 rpm.

The fluid-cooled five-axis motorized milling spindle (power 11 kW, torque 19/30 Nm, speed up to 18000 rpm) has hydrostatic bearings in the Y/B-axes. The stable circular guide further ensures excellent rigidity and damping. The Y-axis features a ±80 mm stroke. The B-axis driven directly by a torque motor has a swivel range of –50 to +230 degrees. With a large travel distance in the X-direction, machining at up to 30 mm below the turning center height is possible.

The motorized milling spindle operates using a one or optionally two-row tool chain magazine which features space for 70 or 140 tools (HSK-A40). The double-row tool magazine enables setup during machining time.

A tool turret located in the lower part of the machine can accommodate VDI 25 and VDI 30 tool mountings in 18 or 12 stations, respectively, all of which can be equipped with individually driven tools (power 6 kW, torque 18 Nm, speed 7200 rpm).

The compact machine features a CNC-controlled programmable gantry-type removal unit for finished workpieces. It can unload remnants from the main spindle as well as finished parts from the counter spindle. The G220 offers a generous work area, so operators have easy access to the main and counter spindles, the turret and the motorized milling spindle, as well as the operating panel.

The G220 utilizes the latest generation of the INDEX C200 SL controller. Based on the Siemens Sinumerik 840D sl (solution line), it features an 18-inch touchscreen. The operating panel can do more than just operate the machine. It features a second input which INDEX uses for its own Virtual Machine (VM) program simulation (optional). By pressing a button, the operator can switch to "VM on Board" and make use of simulation, irrespective of current machine operations.

For more information:
INDEX Corp.
Phone: (317) 770-6300
www.indextraub.com

Kapp Technologies

N-7036

Kapp Niles will feature three machines at the International Manufacturing Technology Show (IMTS).

KX 100 Dynamic Gear Center

The KX 100 Dynamic gear center is uniquely designed for mass production of external planetary gears up to 125 mm. Its independent twin "pick-up" work spindles provide much more than optimum productivity. Tooling setup time is drastically reduced, work arbor change and verification is automated, and grinding worm change is semi-automated. The KX 100 will be exhibited as a turn-key solution with "basket stacker" automation and tooling. An integrated pallet conveyor (pictured) offers a robust solution for considerable space and cost savings. "The KX 100 machine is already being used in the automotive market with great success," said Bill Miller, vice president of sales at Kapp Technologies, "and we are excited to show this machine at the show."

ZE 800 Gear Profile Grinding Machine

Kapp Niles' ZE 800 Gear Profile Grinding Machine will be on display to highlight its capability of internal grinding and measuring of high helix internal gears up to 40 degrees. The ZE 800 (and ZE 400) are known for compact, ergonomic and productive solutions for a range of profile grinding applications up to 25 module (1 NDP). Software and HMI are intuitive, making setup fun and reliable.

PGM400 Measuring Machine

Kapp Niles will also unveil the new PGM400 measuring machine from Penta Gear Metrology. The PGM400 extends Penta Gear's smaller ND165 and ND300 machines. Speed and precision are outstanding on the PGM400. Windows software has been developed for easy setup and analysis.

A wide array of Kapp non-dressable CBN tools for profile grinding, DIA dressers for threaded wheels, superfin-

ishing tools and DDG for honing will also be on display.

Kapp Niles continues to lead with the expansion of manufacturing solutions that streamline entire processes with intuitive, automated and integrated systems. This is complemented by the measuring machines from Penta Gear Metrology, and the larger custom measuring machines from R&P Metrology, which offer the high quality and precision Kapp Niles is known for. For more information:

For more information:
Kapp Technologies, LP
Phone: (303) 447-1130
www.kapp-niles.com

Klingelnberg
N-6827

C 30 Bevel Gear Cutting Machine

Due to ongoing advancement of the vertical concept, the Oerlikon bevel gear cutting machine C 30 is designed to set new standards in dry processing. All machines in this series are equipped with a thermostable, vibration-damping machine bed. An optimized axis arrangement also ensures reduced approach paths, and thus significantly less load on the drive components, and a more rigid design of the overall system. Moreover, an integrated deburring tool enables maximum productivity and utmost process safety through the use of the Pulsar method.

P 40 Precision Measuring Center

The fully automatic CNC-controlled precision measuring center is designed as a compact unit for the workpiece diameter range up to 400 mm. At the heart of the P 40 is an accurate, durable rotary table. Configured as a measuring axis (C axis), it provides concentric seating of the workpieces to be tested.

All precision measuring centers are now equipped with new versions of the calibration software and an advanced graphical user interface. The new Windows user interface, soon to be established on the market under the "EasyStart" brand, allows the machine operator to operate the machine in a manner that is both significantly easier and target-oriented. A clearly structured user interface, displayed by a tiled layout with appropriate symbols for the specific measuring application, ensures a quick and easy program start on the gear measuring machine. Most machine operators will already be familiar with this type of application from the current general Windows system interface.

Optimized Small Batch Production

The industrial gear unit sector comprises many different applications, all of which place great demands on the reliability of gear wheels. The cylindrical gears for these sectors are often produced by companies specializing in small batch sizes and a variety of products. A stiff machine design and flexible, cost-effective tool systems are the keys to success for ranking among the market leaders in these sectors. With the Viper 500 machine variants, Klingelnberg has developed a modular technology platform that gives contract gear manufacturers in particular a leg up on the competition thanks to maximum process efficiency and unparalleled production quality.

Viper 500 W Cylindrical Gear Grinding Machine

The Viper 500 W cylindrical gear grinding machine is designed for component diameters up to 500 mm and specifically for small to medium-sized batches. To suit individual requirements, the machine is available in three different configurations: profile grinding, small grinding wheels for custom jobs, and multiple-wheel technology (K) as well as generation grinding (W). The Viper 500 W configuration allows both profile grinding and continuous generation grinding on the same machine with minimal retooling time.

On all variants, the optional internal gear grinding arm allows retooling from external to internal gearing. Moreover, the special machine axis arrangement is a contributing factor in the machine's tried-and-tested precision and consistent quality, as well as tremendous flexibility. The highly dynamic axes allow optimized 5-axis machining of an entire range of modifications in the shortest possible grinding time.

For more information:
Klingelnberg America
Phone: (734) 470-6278
www.klingelnberg.com

Koepfer America
N-6918

Koepfer America will feature several new pieces of technology at IMTS 2016.

Model 200 CNC Gear Hobbing Machine

The Koepfer Model 200 CNC gear hobbing machine will be shown with new, advanced software for the hobbing of non-circular gears. This type of gear demands complex calculations and formulas for the hobbing process, and

Koepfer engineers are readily available to adapt any feasible convex contour. Pump motors and other specialized applications make use of non-circular gears to ensure precise nonuniform transmission of motion.

CLC 100-SZ CNC Gear Shaping Machine

Also at IMTS, the CLC 100-SZ CNC gear shaping machine will be demonstrated. This highly customizable machine offers an extensive feature set. In detail, this new 120 mm (4.724 in) diameter machine offers heavy duty construction, direct drive torque motors, up to 2,000 strokes per minute, up to 100 mm (3.937 in) of stroke length, a moving saddle, optional tilting column, orientation probe, electronic helical guide and CNC relief. Additionally, this feature-packed shaping solution is available with twin work spindles, which allow easy loading and unloading of a part simultaneously with the shaping of another work piece. Consequently, machine chip-time can be maximized. Gear manufacturers will discover in the CLC 100-SZ a workhorse for both job shop flexibility and volume production.

Monnier + Zahner 500 D-Drive CNC Gear Hobbing Machine

The newly introduced Monnier + Zahner (MZ) 500 D-Drive CNC gear hobbing machine will also be on display at IMTS. This hobbing solution features a double drive system for flexible clamping of workpieces with less tailstock pressure, which is ideal for ultra-fine-pitch parts. The machine also offers optional automatic loading and unloading, hob shifting, deburring, a small footprint, and a cost-conscious design.

Lastly, Koepfer America will show Helios gear cutting tools and Tyrolit hard finishing tools. Gear manufacturers can also visit the Koepfer America booth to learn more about Wenzel CNC gear inspection machines, the KFS CNC gear tool sharpening machine, and the latest available used equipment. For all gear manufacturers, Koepfer America is a top choice for machine and tool solutions.

For more information:
Koepfer America, LLC
Phone: (847) 931-4121
www.koepferamerica.com

Liebherr Gear Technology, Inc.

N-6930

LGG 280 Gear Grinding Machine

With a one-table design and a new-design grinding head, the new Liebherr LGG 280 gear grinding machine greatly reduces grinding times for twist-free profile and generating grinding of workpieces to 280 mm diameter.

Presented for the first time in North America at IMTS, the machine is the second in the LGG series and is designed to deliver consistently high large-scale production quality in automotive applications, including conical gearing. With it, manufacturers can produce smaller gears with greater load-carrying capability. (See the full presentation of the machine at *www.youtube.com/watch?v=b2PG1GJPRUE*)

According to a Liebherr spokesman, "With this series of space-saving machines, vehicle manufacturers can develop a complete production line, in which all gearing components for a passenger vehicle transmission can be ground: planetary and sun gears, bore-type gears, as well as drive and pinion shafts with lengths up to 500 mm."

The advantage to the one-table solution is higher quality throughout the entire production. There is one clamping fixture, one geometry. Every machined part is manufactured under the same conditions for high reproducibility. The one-table approach provides the statistical capability and reliability in continuously producing controlled µ-range finish quality for gear noise optimization.

The new grinding head allows for rotation speeds up to 10,000 rpm and has spindle power of 35 kW. With this performance data, the head enables high cutting speeds and high feed rates.

The new grinding machine can exploit the considerable potential of the innovative 3M abrasive Cubitron II. Changing the grinding arbor with HSK-C 100 tool holder is a fast and simple process. Also available is a second grinding head for featuring a small worm diameter for collision-critical parts.

The machine will enable undulations to be applied specifically to gear wheel flanks for noise optimization purposes for the first time. The ability to produce sub-µ range waviness cost-effectively gives designers a whole new range of optimization options.

The touch screen user interface on the machine control permits easier, intuitive programming and machine operation and incorporates an integrated webcam. The control also can incorporate substantial additional documentation, such as fixture layouts and tool mounting instructions.

The LGG machines are easily coupled with Liebherr automation solutions to create a fully automated production line for the highest quality gears in the least possible cycle times.

For more information:
Liebherr Gear Technology, Inc.
Phone: (734) 429-7225
www.liebherr-us.com

LMC Workholding

W-1314

LMC Workholding will display a variety of its workholding product line, including face drivers, wheel chucks, cylinders, steady rests, specialty workholding products and more. Also displayed will be a new chuck, from LMC's new partner Rotomors of Turin, Italy. This extra-large chuck is an automatic self-centering, down-clamping and indexing chuck.

The FRB face drivers on display feature a patented mechanical compensating system, which is highly adjustable and reliable in the most difficult conditions. Work positioning is maintained with optimal repeatability. The use of centers with slots also allows turning of pipe, or workpieces with holes in the end.

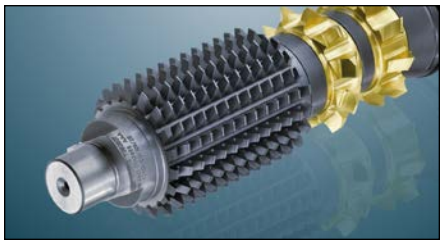
Hydraulic and manual steady rests will also be exhibited. Atling self-centering steady rests maintain the integrity of shaft or bar workpieces that tend to bend or deflect under unstable cutting loads. LMC Workholding/Richter manual steady rests are manufactured to customers' applications, from small standard, ring style and special steady rests to large, complex units.

LMC also offers specialty workholding with Stiefelmayer clamping solutions for highly specific applications. The product line consists of workholding chucks and mandrels with integrated hydraulic compensation and other special clamping tools.

For more information:
LMC Workholding
Phone: (574) 735-0225
www.LMCworkholding.com

LMT Tools

W-1732



For decades LMT Tools has been an expert in producing cutting tools for the production of gears, focusing on optimized productivity and increased cutting speeds in industrial manufacturing. Being technologically advanced, LMT Tools offers a wide tool range for gear cutting in the market. The product range includes small-module and large-module tools for the roughing and finishing of gears.

In 2010 the company launched Nanosphere, the world's first nanostructured multilayer coating for gear hobs. This high-tech coating protects tools against the extreme conditions of the machining process.

For hobs and involute gear cutters with indexable inserts, LMT Tools developed Nanotherm, a heat resistant coating which protects blades against the high temperatures that occur during the milling of large gears.

Working with a manufacturer of gear cutting machines, LMT Tools developed the ChamferCut tool system that enables users to carry out gear cutting and deburring in a single work process.

LMT Tools' most recent hob development bears the name Speedcore. The special feature of this tool is its intermetallic core, which facilitates significantly higher cutting speeds.

As a partner for complete gear production systems LMT Tools offers users in the automotive and wind energy industries a comprehensive range of products and services, from initial tool procurement to tool reconditioning.

For more information:
LMT USA, Inc.
Phone: (847) 687-5924
www.lmtusa.com

Luren Precision

N-6960

LGA-2812 Continuous Generating Gear Grinding Machine for Gear Class AGMA 14

Luren brings you the all new LGA-2812 CNC continuous generating gear grinding machine. LGA-2812 is built on a Reishauer NZA, AZA machine base, utilizing an advanced Siemens Sinumerik 840D CNC controller, high-speed workpiece spindle, and grinding wheel spindle. The Luren-designed and -created gear grinding software acts as an interface between Luren grinding machines and the Siemens 840D controller. Minimal CNC experience is necessary to operate this machine.

Other features include a Swiss made NUM controller, a Windows-based operating system, an 8-axis control system, a single diamond rotary dresser and optional automation. The LGA-2812 is equipped with high speed spindles. The workpiece spindle operates up to 600 rpm. The grinding wheel spindle operates up to 5000 rpm.

Luren LFG-3540 Horizontal Gear Profile Grinding Machine for Gear Class AGMA 14

Luren Precision has developed the high-precision LFG-3540 CNC gear profile grinding machine. With a firm machine

base of one-piece casting, direct drive motor with zero backlash and closed-loop optical scale for feedback control, the LFG-3540 makes high precision gear grinding a reality with a maximum capability of 400 mm in outside diameter. The LFG-3540 also has a powerful software function that allows flexible definitions of gear data and processing conditions. Fine tuning on gear profile, lead and pressure angle can be easily achieved based on measurement results. The LFG-3540 is designed to be a CNC gear profile grinding machine with one of the best performance-to-price ratio in the market.

Features include a combination direct drive motor and linear motor, special profile grinding for spur gears, pump gears and helical gears, automatic stock dividing, a point or rotary diamond dresser and on-board inspection capabilities.

Matrix Model 0550 External Thread Grinding Machine

The Matrix Model 0550 features a servo motor driven work head, a Siemens 840DE CNC control, a motorized wheel head, a coolant clarification system, automatic wheel balancing, a centrifugal separator, a programmable helix, a magnetic separator, absolute encoders fitted on all configured axes, a spindle chiller unit, a manual tailstock, a totally enclosed hood, a work head mounted dresser, a fume extraction system, a remote diagnostics system, air conditioning (ECC), one diamond dressing media, two MT work centers, one grinding wheel, one test grind (customer) part and the Matrix Profile MATE Software. Installation and commissioning is also available.

For more information:
Luren Precision Chicago Co., Ltd.
Phone: (847) 882-1388
www.lurenusa.com

Mahr Federal Inc.

E-5614

Mahr Federal will feature the MarShaft Scope 250 Plus, the new MarShaft Scope 600 Plus 3D, and the MarGear GMX 400 at IMTS 2016. Also on display will be several custom gaging solutions developed by the MarSolutions Engineered Metrology Team.

MarShaft Scope 250 Plus Optical System

Mahr Federal's MarShaft Scope 250 Plus flexible optical system for shop floor measurement is competitively priced and designed to provide fast, accurate, fully automatic measurement of smaller shafts and turned parts directly on the shop floor. It features a highly accurate matrix camera with four million pixels, and measures parts up to 250 mm in length and 40 mm in diameter. Its MPE (Maximum Permissible Error) of less than 1.5 microns +L/40 when measuring diameter and 3 microns +L/125 when measuring length is more accurate than other systems using line cameras.

MarShaft Scope 600 Plus 3D Optical/ Touch Sensor

The new MarShaft Scope 600 Plus 3D, introduced at this year's Control Show, will also make its debut appearance at IMTS 2016. Combining optical and touch sensors in the same unit, the MarShaft Scope 600 Plus provides 3D functionality and complete inspection of the workpiece in a single measurement. In a matter of seconds, the matrix camera optically measures characteristics such as diameter, length, radius, shape, location characteristics, etc., while a new 2D sensor detects features that are not optically measurable, such as cam lift on concave cam profiles and reference (clocking) features such as holes or keyways.

MarGear GMX 400 Universal Gear Tester

The MarGear GMX 400 is a Class 1 Universal Gear Tester that provides fast, accurate analysis for a wide range of gear and gear tool applications on gears with ODs up to 400 mm (15.75 in). Part of the Mahr Federal GMX Series, the GMX 400 incorporates a 4-axis Power PC controller with automatic tailstock and a high-accuracy 3D scanning probe head. The GMX 400 provides an excellent solution for both universal and specialized gear manufacturing processes.

The GMX Series is designed to provide maximum precision and flexibility of gear and form measurement in a single system. Equipped for standalone shop floor or gear lab applications, the GMX 400 can also be fully networked for fast and efficient transfer of measuring results and machine corrections. The GMX Series provides Class 1 accuracy in accordance with VDI/VDE 2612/2613 Group 1.

MarSolutions Engineered Metrology

Mahr Federal will also be exhibiting a wide range of its MarSolutions Engineered Metrology Team capabilities. Custom gage stations will reflect the three levels of design solutions available from Mahr Federal, including modified standard product gages, gages configured from Standard Elements, and gages custom built for the application. Also, reflecting industry's drive to automation, MarSolutions examples will demonstrate manually operated gages, semi-automatic solutions, and fully automated robotically loaded gaging stations -- thus providing the full range of custom design solutions from the MarSolutions Team.

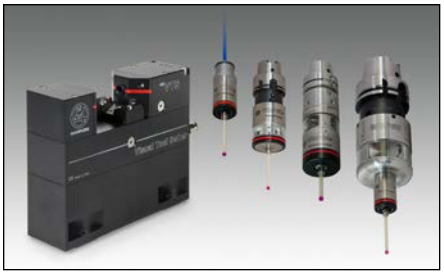
For more information:
Mahr Federal Inc.
Phone: (401) 784-3100
www.mahr.com

Marposs Corp.

E-5516, S-8719

Mida Diamond Touch Probes and Tool Setters

Marposs will introduce its new Mida Diamond line of high precision machine tool touch probes and tool setters at IMTS 2016. The Mida Diamond line has been developed to assist in controlling the entire production process in all its phases: from work-piece set-up and inspection to tool pre-setting and control. The high precision products address industries that require high accuracy controls on very complex surfaces such as aerospace, biomedical and dental, mold and die production, and micro-manufacturing applications.



Mida Diamond Touch Probes for part checking are designed to guarantee exceptional measuring performance thanks to piezoelectric technology. The probes are available with various transmission methods including wired transmission, optical transmission and radio transmission.

The Mida Diamond Visual Tool Setter (VTS) for tool checking implements a vision technology using a video camera to detect tool dimensions, in particular those of micro-tools, and for complex measurements. VTS can be used together with dedicated measuring software, for checking a wide range of tools, guaranteeing repeatability of less than 1µm.

Advantages of the new Mida Diamond probing line include reduced machining and checking times, increased production efficiency, reduced production rejects, and constant machining quality level during the entire production process.

For more information:
Marposs Corp.
Phone: (248) 370-0404
www.marposs.com

Mitsubishi Heavy Industries America Inc.

N-7046

Mitsubishi supplies a wide variety of gear manufacturing machines, including hobbing, shaping, shaving, grinding and gashing machines, along with related cutting tools.

For more information:
Mitsubishi Heavy Industries America Inc.
Phone: (248) 669-6136
www.mitsubishigearcenter.com

Nachi America Gear Tools Division

W-2245

Nachi America will be presenting their newest coating release. GX coating for broaching and GP coating for hobs.

GX - Ensures consistent accuracy and improved wear resistance with long tool life with both water soluble cutting fluid and water-immiscible cutting fluid.

GP - Coating Suitable for both dry and wet hobbing Supports a wide range of machining environments and methods Exhibits the best performance in conventional cutting range (Cutting speed 80 to 180m/min)

For more information:
Nachi America Inc. Gear Tools Division
Phone: (317) 530-1004
www.nachiamerica.com

Norton/ Saint-Gobain Abrasives

N-7051

Norton Century45 Centerless Bond Platform

Norton/Saint-Gobain will feature Norton Century45 centerless grinding wheels at IMTS 2016. The newly developed Norton Century45 centerless bond platform features an exclusive chemistry that greatly improves grain retention in the wheel. Better grain retention means wheels are constructed with more porosity for a given hardness. This translates into wheels having a hard grade with the performance of a softer grade, providing a range of benefits.

Norton Century45 wheels are available with ceramic, aluminum oxide, silicon carbide grain and abrasive blends to maximize user grinding safety and efficiency. These wheels reduce cycle times by up to 50 percent, improve stock removal by over 30 percent and increase wheel life from 30 percent to 100 percent versus standard products currently on the market.

Norton Century45 provides a continually sharp wheel face that achieves over 30 percent more stock removal, reducing grinding times through fewer passes to achieve optimal results.

Operators will generate more parts through reduced production cycle times when using Norton Century45 wheels.

Norton Century45 centerless grinding wheels also can decrease grinding noise levels by as much as 23.2dB, even when grinding hard-to-grind alloys such as Inconel 718, thus increasing operator safety. To put this noise reduction in

context, many commercially-available foam ear plugs offer Noise Reduction Ratings in the range of 25 to 28dB.

Norton Century45 is ideal for bar grinding, fastener and tool grinding, automotive or aerospace components, as well as bearing applications. Whether in a high production grinding facility or job shop, Norton Century45 can significantly reduce grinding costs while increasing safety and production throughput.

For more information:
Norton / Saint-Gobain Abrasives
Phone: (508) 795-5626
www.nortonabrasives.com

Oelheld U.S. Inc.

N-7475

SintoGrind IG 540

Oelheld's SintoGrind IG 540 grinding oil is designed for flute grinding, profile grinding and outside and inside diameter grinding. SintoGrind IG 540 works on a wide variety of materials including tungsten carbide, HSS, PCD, CBN, cermet and ceramics.

Features of the SintoGrind IG 540 include protection against cobalt leaching, low foaming, high-quality surface finish, superior ageing, excellent flushing and cooling properties, low evaporation and misting and a high flash point. The SintoGrind IG 540 is also physiologically safe and is designed to have a pleasant odor.

ToolGrind TC-X 620

Oelheld has introduced ToolGrind TC-X 620 as its high performance grinding oil. ToolGrind TC-X 620 incorporates the additive technology from Oelheld's flagship product SintoGrind. The product is designed for flute grinding, profile grinding and outside and inside diameter grinding. ToolGrind TC-X 620 works on a wide variety of materials including tungsten carbide, HSS, PCD, CBN, cermet and ceramics.

The TC-X 620's features are identical to the IG 540's:protection against cobalt leaching, low foaming, high-quality surface finish, superior ageing, excellent flushing and cooling properties, low evaporation and misting and a high flash point. The ToolGrind TC-X 620 is also physiologically safe and is designed to have a pleasant odor.

SintoGrind TC-X 630

SintoGrind TC-X 630 is designed to be Oelheld's new entry level product to its flagship SintoGrind series. SintoGrind TC-X 630, with its new base oil technology, is designed for flute grinding, profile grinding, and outside and inside diameter grinding.

SintoGrind TC-X 630 works on a wide variety of materials including tungsten carbide, HSS, PCD, CBN, cermet and ceramics. SintoGrind TC-X 630 was especially formulated for demanding grinding tasks and delivers exceptional feed and speed rates with superior surface finish. Its lubricity lends to extended wheel life and minimal heat build-up, which in turn eliminates surface cracks and burns.

For more information:
Oelheld U.S. Inc.
Phone: (847) 531-8501
www.oelheld-us.com

Oerlikon Balzers

W-2380

Balinit Altensa

The Balinit Altensa is the newest product in the successful AlCrN family that stands out through its wear resistance and hot hardness. The coating properties at high temperatures were specifically targeted for optimization. "Essentially, we further reduced the thermal conductance and improved the hot hardness of the coating by a good 20 percent," explains Wolfgang Kalss, head of marketing and product management for cutting tools. This has led to even higher resistance to crater wear, which can occur particularly at high service temperatures and reduces the useful life of the tool.

Moreover, the abrasive wear resistance was optimized by about 35 percent as was the oxidation resistance. This reduces the flank wear at moderate and high cutting speeds and it yields a longer tool service life, even with dry machining. The numerous improvements in layer development enable considerable productivity gains with longer tool lifetimes, significant performance boosts at the highest cutting speeds for all substrates (PM HSS, MC90, carbide) as well as higher cutting speeds and feeds. Customer tests with various gear-cutting applications yielded corroborative results.

The versatility of Balinit Altensa is also proven in lubricated machining, in which initial results demonstrate a significant increase in service life.

Tests by an automotive supplier demonstrated that productivity can also be clearly improved for carbide stick blades. At a cutting speed increase of 35 percent to vc = 200 m/min, a 30 percent improvement in service life was also achieved

at the same time. Another automotive supplier tested coated HSS shaper cutters (diameter of 130 mm) in lubricated machining and the tools lasted 140 percent longer.

For more information:
Oerlikon Balzers
Phone: (800) 792-9223
www.oerlikon.com/balzers

Reishauer Group

N-7040

The Reishauer Group, with its two companies, Reishauer and Felsomat, highlights its combined gear manufacturing process: from blanks to perfectly ground gears.

Felsomat

FHC 80 Hobbing Center

The Felsomat Flexible Hobbing Center FHC 80 provides the competitive edge in manufacturing with chip-to-chip times of less than one second. Especially developed for high-speed cutting for transmission manufacturing, the FHC 80 reduces the machining time to a level deemed unreachable so far. Chamfering and deburring can be achieved in parallel to the cutting process, due to the twin-spindle machine concept, and secondary burrs can be completely eliminated. In combination with an ultra rapid integrated loading system, it is possible to achieve machining times of less than 8 seconds per work piece, and all this with a minimum of floor space and a maximum of work area.

The machine will be shown at IMTS equipped with Felsomat's new High Density V (HDV) Conveyor, which delivers fast, flexible and affordable automation in gear manufacturing.

- High density of gear blanks in an extremely compact footprint.
- Simple method of manual skewering of gear blanks from dunnage and transfer to the HDV conveyor.
- Controls of conveyor fully integrated in machine cabinet for smaller footprint and optimized capital investment.
- V design ensures gears are always on center line for easy acquisition by the automation system and machine loading.
- V design can easily accommodate a wide variety of gear diameters without any conveyor changeover.
- Quick changeover of transfer tooling.

Unloading finished gears from the HDV conveyor can be easily integrated with a Felsomat Stacking or Robot Cell FSC 600 or FRC with wire baskets for automation of all downstream processes, or directly into heat treatment alloys.

Latest version of the Flexible Stacking Cell, the FSC 600

This new cell is completely built on a fabricated base for easy transportation and quick installation. The base is also designed to contain any cutting fluids that may be required in the machining process and prevent those fluids from migrating to the factory floor. Additionally, the cell features active basket hanger locks that ensure an accurate and uninterrupted loading sequence and allow for a higher tolerance in the baskets. This type of automation is available with a gantry loader or with a Fanuc robot and can be ordered with advanced crash detection systems.

Reishauer

RZ260 Gear Grinder

On the Reishauer side, an RZ260 gear grinder equipped with two work spindles will be shown off. As soon as one workpiece is ground, the turret swivels around by 180 degrees so that the machine can immediately start grinding the next part. The twin-spindle arrangement eliminates the idle time between grinding cycles. While one workpiece is being ground, the other is simultaneously meshed and oriented into the correct grinding position. To complement its range of machines, Reishauer produces its own grinding wheels, workholding and diamond dressing rolls. In this way, the company can truly guarantee that all elements of the grinding process — the machine and the tooling — are fully under control.

The complete gear manufacturing process is supplied from within the Reishauer Group. If customers embark on a new project, they can rely on partners that understand all the elements that make up the gear manufacturing process; partners who can supply all the technology from machines to process parameters, grinding wheels, diamond dressing rolls, fixturing and material handling. In their field of activity, Reishauer and Felsomat guarantee the proper functioning of all these elements of the complete gear manufacturing solution.

For more information:
Felsomat USA, Inc.
Phone: (847) 995-1086
www.felsomat.com

Reishauer Corp.
Phone: (847) 888-3828
www.reishauer.com

Schneeberger J. Corp.

N-6936

Aries NGP Tool Grinder

The latest addition to the machine offerings from Schneeberger, the new Aries NGP, answers to the need for an affordable tool grinder with all the power of the big machines. Aries NGP offers almost 10 Hp duty rated power with the direct drive double ended spindle and the accuracy of HSK50 wheel arbor interface. The machine has been designed to fit even in the smallest space, barely 3 feet wide and just over 5 inches deep, the machine offers a 10" × 10" work envelope, integrated coolant, and powered by Schneeberger Quinto Qg1 software, the only CAD tool programing software creating tool programs in

seconds. All this made possible by the reliability and accuracy of the FANUC 31 series control system. The machine is perfect for sharpening hobs, shaper cutters, straight or spiral and any other tool.

Norma NGC Tool Grinding Machine

The Norma NGC is Schneeberger's universal 5-axis tool grinding machine for both production grinding and tool servicing. It offers a complete contingent for full automation: 7-station integrated wheel pack loader with coolant manifold, integrated tool loader and the ideal corresponding clamping systems for any tool type. Equipment with the new Zenon 3D probe measures wheel forms as well as tool geometries. The grinding spindle delivers full 13 Hp (at 100 percent) with extreme torque for highest stock removal.

The rigid and compact 5-axes kinematic is designed to assure best grinding results. The open structure and accessible utility compartment enables for easy and quick PM on the hydraulic and pneumatic components of the machine. The Fanuc 31i B5 control guarantees fast and accurate positioning of the machine axes and is marketed for its reliability and longevity.

The machine stands out in energy savings due to the automatic switch off of several user components after the last machine function has ceased. The machine reduced energy consumption by 92 percent in standby mode.

The specific machine application range and accuracy allows for manufacturing or sharpening of a variety of tools, such as end mills drills inserts, hobs, shaper cutters and a wide range of other tools. The Norma NGC has been designed to be one of the most universal machines in the market.

For more information:
Schneeberger J. Corp.
Phone: (847) 888-3498
www.schneeberger-us.com

Seco Tools

W-1564

Square T4-12

With larger insert sizes, Seco's T4-12 line of square shoulder and helical milling cutters allows parts manufacturers to achieve increased depths of cut and higher metal removal rates when roughing and semi-finishing steel, cast iron and other workpiece materials.

The bigger inserts all come with four curved cutting edges that lower tooling cost per part and ensure smooth machining operations. They tangentially mount in the cutter bodies for increased performance stability and easier access to their mounting screws. Plus, this mounting design directs cutting forces to the thickest part of the inserts, which contributes to their higher metal removal capability.

Cutter diameters for the larger T4-12 square shoulder inserts range from 1" to 5" (25 mm to 125 mm), with corner radii up to 0.125" (3.1 mm). Diameters for the larger T4-12 helical inserts range from 2" to 4" (50 mm to 100 mm), with corner radii up to 0.125" (3.1 mm). The inserts also come in a wide selection of grades and geometries as well as in normal and close pitch versions.

Highfeed 6

Seco's new high-performance Highfeed 6 milling cutter easily tackles a variety of difficult-to-machine materials from stainless steel to heat-resistant superalloys. The large-diameter cutter bodies are capable of 0.070" (1.8 mm) axial depths of cut and feature double-sided inserts with six cutting edges for unsurpassed material removal and low operating costs.

Niagara Stabilizer 2.0

The Niagara Stabilizer 2.0 next-generation — STR-430 and STR-440 Series — solid-carbide end mills offer metal removal rates double those of their predecessors. Also, with twice the chip load capacity, the new versions shorten part machining cycle times and further boost productivity.

The end mills come in diameters from 0.125" to 1.0" with square corner and corner radii, based on series and diameter, of 0.010", 0.020", 0.030", 0.060" and 0.120". Lengths are 1×D, 2×D and 3×D, and shanks are either cylindrical or have Weldon Flats.

TP grades (Duratomic)

Incorporating Seco's Duratomic Technology, TP2501, TP1501 and TP0501 turning grade inserts feature the company's Chrome Used-Edge Detection, making it easy to avoid insert waste without sacrificing tool performance.

The TP2501, TP1501 and TP0501 inserts offer an expanded choice of solutions for workpieces in the ISO P materials category of steel as well as additional applicability in stainless steel and cast iron. With a broad working range, the TP2501 grade provides dependable productivity and reliable part production in most steel-turning applications. TP1501 is a general grade with well-balanced properties for applications that require high wear resistance and excellent surface finish in low-alloy carbon steel workpieces.

TK grades

Additional Duratomic-technology-based Seco grades that will be at IMTS are the company's TK1501 and TK0501 grades designed for exceptional performance in cast iron turning. The inserts

are tough, wear resistant and process more parts per edge. The Duratomic coating expands their application range while increasing overall tool life and productivity through a balance of toughness and hardness for the highest performance. Both TK1501 and TK0501 also feature Chrome Used-Edge Detection to minimize waste.

For more information:
Seco Tools
Phone: (248) 528-5200
www.secotools.com/us

SMW Autoblok Corp.

W-1400

Chuck Changing System

At IMTS 2016, SMW Autoblok will be introducing the Chuck Changing System (CCS) to the North American market. Designed for quick changeover of workholding on CNC turning machines, standardized adapter parts allow the use of different kinds of workholding (for example 2-jaw chucks, 3-jaw chucks, collet chucks, mandrels and manual fixtures) with the same system.

Changing a chuck with CCS takes minutes. A turn of the key connects any workholding device to the machine spindle as well as to the drawtube of the actuating cylinder. The hardened and precision ground CCS and adapter parts ensure the highest repeatability and changeover accuracy. A large through hole and a visual control for the locking status add to the unit's versatility. The CCS can be installed onto new machines or can be retrofitted to any existing CNC lathe.

The CCS is now available for ASA spindles A6, A8, A11 and for cylindrical spindles for diameters Z170, Z220, Z300.

For more information:
SMW Autoblok
Phone: (847) 215-0591
www.smwautoblok.com

Solar Manufacturing

N-6358

Solar Manufacturing will be introducing a new, innovative and more thermally efficient hot zone design at IMTS 2016 in Chicago. Recent successful tests of a new graphite insulation board in the hot zone of an existing furnace promises exciting results compared against existing insulation materials used in current hot zone designs. It is more thermally efficient and extremely strong and durable.

Solar Manufacturing will also be showing off their other furnace lines. Models ranging from compact lab furnaces, mid-size horizontal production furnaces, large car-bottom furnaces, and vertical bottom loading furnaces.

For more information:
Solar Manufacturing
(267) 384-5040
www.solarmfg.com

Speedgrip Chuck

W-2194

Quick Change Adapter System

Speedgrip will be showing their new Quick Change Adapter System. Merging the tested and true Camlock adapter type with today's carrier and receiver system is designed to provide a solution that is accurate, fast, and affordable.

Setting up is quick. The Camlock adapter "receiver" is placed on the spindle. A receiver and retention knob retainer is attached to the jaw chuck, collet chuck and face driver and you are ready to go. To change chucks, simply release the cam studs, move the drawtube forward, remove one chuck, slide on the other, tighten the studs, retract the drawtube, and in 5 minutes you have a completely different chuck and are ready to go. Users can change from a jaw chuck to a collet chuck in less than 5 minutes, from a collet chuck to a face driver in less than 5 minutes and then back to a jaw chuck in less than 5 minutes.

The Quick Change Adapter System is more affordable than Curvic coupling quick change adapters and available in sizes A-5 to A-15. As an additional feature, the drawbar sub-assembly that can be adapted for either draw tube or drawbar.

For more information:
Speedgrip Chuck
(574) 294-1506
www.speedgrip.com

Star SU LLC

N-6924, W-2258

Star SU will have two booths again this year — one in the gear pavilion in the north hall and another in the west hall showcasing cutting tool technology.

Booth N-6924

Product overviews, video displays and Star SU's new interactive customer application guide solution tool for Star SU's full line of product and technology offerings. IMTS visitors can explore independently or have a Star SU representa-

tive guide them through the company's complete machine tool, cutting tool and tool services offerings from the brands they represent, including Star Cutter Company, Samputensili, Bourn & Koch, SICMAT, Profilator/GMTA, FFG Werke (Huller Hille, Hessapp, Modul, VDF Boehringer), H.B. Carbide and Sandvik Coromant.

Samputensili SG 160 Sky Grind Gear Dry Grinding Machine (N-6924)

Star SU offers the Samputensili SG 160, the first gear dry grinding machine in the world that can grind gears without using coolant. This evolution of the gear generating grinding process ensures short cycle times, even less than traditional machines (less than 2 seconds). Watch a video demo, learn more about the machine and plan to visit Star SU's exhibit by going to their dry grinding page.

Bourn & Koch 400 H CNC Horizontal Hobbing Machine (N-6924)

Bourn & Koch 400H 7-Axis CNC Horizontal Gear Hobber features Fanuc CNC control and an industry exclusive point-to-point array hobbing capability. Ideal for longer spline shafts, spur and helical gears up to 400 mm diameter, 6.4 max module. For more information, visit Star's 400 H horizontal hobbing webpage. Request a budget quote and plan to see it at IMTS by visiting Star's 400 H horizontal hobbing webpage.

FFG Werke Modul H200 Vertical Hobbing Machine (N-6924)

The H 80/100/130/160/200 series is the latest version of Star's hobbing machine line for small automotive applications. These machines have been designed for dry cutting applications in particular, although using oil or emulsion is not a problem. Chips are conveyed cleanly from the work area by means of a chute, which is steep and smooth in design to prevent any build up. The hob head is housed within the tool column, which is tightly fastened to the sturdy machine bed. The tailstock is located on the tool column above the hob head, leaving the work area free for workpiece loading and unloading operations.

Star SU Gear Cutting Tool Solutions

N-6924, W-2258

Star SU carries a wide variety of new gear cutting tools and offers precision tool re-sharpening services and advanced coatings, including Oerlikon Balzer's New Balanit Altensa, the high-speed coating solution that realizes productivity gains and efficiency. Need more help managing your tool room? Let Star SU monitor the life cycle of your tools and re-sharpen, re-coat and replace them as needed. Visit *www.star-su.com/cutting-tools/gear-cutting-tools* and request a meeting with Star to discuss how they can help you with your gear cutting operation.

Star SU will also feature Scudding cutters in conjunction with GMTA and Profilator manufactured to produce gear and spline teeth for reduced cycle times and tool costs. Learn more by visiting us at IMTS or going directly to Star's scudding page.

Gundrills (W-2258)

Star SU carries a full line of gundrills and deep hole drills, including single flute gundrills, solid carbide single flute gundrills, two-flute two-hole gundrills, double jet gundrills, double crimp gundrills and bi-tip gundrills.

Solid and Brazed Construction Carbide Drills & Reamers (W-2258)

Star SU offers a wide range of precision solid carbide drills and reamers, including solid and braze construction carbide drills and reamers, core drills, Super Round Tool (SRT) reamers, valve guide reamers, multi diameter cavity machining tools and cryogenic machining cutting tools.

Carbide Blanks and Preforms (W-2258)

Star SU offers a wide variety of tungsten carbide blanks and preforms from H.B. Carbide. Using only quality raw materials and employing state-of-the-art, computer controlled vacuum furnaces and vacuum sinter-hipping furnaces, these cemented carbide preforms can be used for cutting tools, dies and wear parts in a variety of specialized applications.

For more information:
Star SU LLC
Phone: (847) 649-1450
www.starsu.com

Suhner Industrial Products

W-1474

Suhner manufactures spiral bevel gears using the palloid, cyclo-palloid and HPGS "hard cut" cyclo palloid methods. In addition, visitors can learn more about Suhner's flexible shafts and electric motor products.

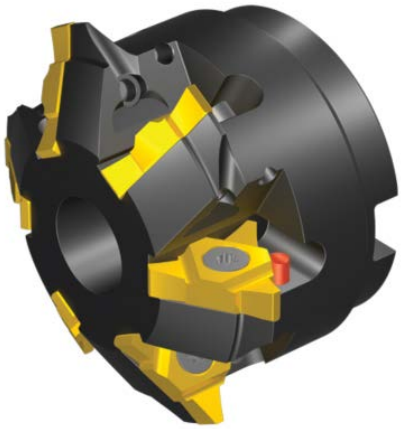
For more information:
Suhner Industrial Products
Phone: (706) 235-8046
www.suhner.com

Vargus USA

W-2446

Gear Milling System

At IMTS 2016, Vargus USA will launch a standard line of indexable and solid carbide gear milling tools for a wide range of gear, spline and rack manufacturing applications. These high precision tools are suitable for machining straight and helical Class 11 AGMA gears ranging from DP 128.0-4.0, ANSI B92.1 involute splines ranging from DP 48/96-4/8 and ISO 14 straight splines. Vargus solid carbide tools range from DP 52-13, and are an excellent solution for machining close to a shoulder. The Vargus Gear Milling System is easy to set up on standard 3.5 axis CNC milling machines and produces a minimum of 50 percent reduction in cycle time compared to traditional hob milling.



For more information:
Vargus USA
Phone: (800) 828-8765
www.vargususa.com

Zoller Inc.

W-2022

HobCheck Gear Hob Measuring Machine

The Zoller hobCheck brings an expanded range of possibilities and solutions to the table with the ability to measure gear hobs according to standards with high accuracy and easy programming, using intuitive data entry and parameter selection.

IMTS2016
International Manufacturing Technology Show
September 12 - 17, 2016 · McCormick Place · Chicago

Conventional gear hob measuring machines only measure hobs in a very rigid way using an old-school, tactile approach which is literally "blind." The Zoller hobCheck opens the eyes to a new level of tool inspection with the ability to measure small hobs that were previously not measureable. For hobs under a certain size, the conventional touch probe alone cannot measure all required parameters, e.g. line of action. The touch probe simply can't reach all required locations on the teeth of the hob. However, this can easily be achieved with an optical approach, and furthermore it's important to note that the camera system tilts in accordance with the lead angle.

Specific characteristics can be re-measured based on the interactive report. Simply select the reported dimension, then the machine positions the tooth in question into field view and allows the user to clean the tooth and proceed with the re-measurement.

»hobCheck« now opens the door to measuring a huge variety of other cutting tools. Examples are form milling cutters (gear milling cutters, rack milling cutters, any free form), (indexable) worm milling cutters, including the ability to generate the actual form cut into the part, shaper cutters, coupons, endmills, drills, reamers, turning tools, inserts, PCD mono block tools, indexable tools and (form) grinding wheels. Unlike a tactile approach, with Zoller's vision system you can determine and document edge wear to minimize removal during regrind.

With the *metis* software module, simple measurements in the camera view can be undertaken at any time and can be processed in a manner of a 2D computer-aided design (CAD). This can be the examination of a chipped edge or a quick angle or radius measurement. Full documentation in form of PDF, WinWord or Excel reports is available for further data processing.

While conventional hob measuring machines simply hold the tools between centers, this is just one option on the »hobCheck«. All tool holding solutions on the market are also possible (for example, HSK, Capto, CAT, KM and straight shank automatic hydraulic chucks).

As an accessory to the hobCheck, the pomSkpGo can measure the edge hone. Both machines share a database so that a complete report on macro and micro geometry on the edge preparation is possible. The ISO9000 certified hobCheck enables a high-level of reverse engineering of any cutting tool, so it's an excellent instrument for research.

For more information:
Zoller Inc.
Phone: (734) 332-4851
www.zoller-usa.com

For Related Articles Search
IMTS
at www.geartechnology.com

Helical Gear Systems

Email your question — along with your name, job title and company name (if you wish to remain anonymous, no problem) to: *jmcguinn@geartechnology.com*; or submit your question by visiting *geartechnology.com*.

QUESTION

In terms of the tooth thickness, should we use the formulation with respect to normal or transverse coordinate system? When normalizing this thickness in order to normalize the backlash (backlash parameter), we should divide by the circular pitch. Thus, when normalizing, should this circular pitch be defined in the normal or traverse coordinate system, depending on which formulation has been used? Is the backlash parameter always defined with respect to the tangential plane or normal plane for helical gears?

Expert response provided by Dr. Hermann J. Stadtfeld, Gleason Corp. A given helical gear is defined e.g. with a certain outer diameter, a pitch diameter and a root diameter. Regarding the number of teeth, the helix angle and the face width, it is important to define their basic dimensions. The transverse module can be calculated by dividing the pitch diameter by the number of teeth. The transverse module, multiplied with the cosine of the helix angle delivers the normal module. Figure 1 shows the difference between the directions of the normal plane and the transverse plane in a top view onto the generating rack.

This brings us to the normal plane, which is used to observe the tooth profile and relate it to a generating rack profile. The generating rack profile describes the active part of the tool profile without taking the backlash into consideration. In order to describe the point width of the tool (in case of zero profile shift), the slot width angle (in the transverse plane) is calculated from 180° divided by the number of teeth. In connection with the pitch radius, the theoretical chordal slot width in the transverse plane (without backlash consideration) can be calculated with:

Chordal slot width (in transverse plane without backlash) = pitch diameter × sin((slot width angle)/2)

Figure 2 explains the relationship between circular slot width and chordal slot width. In order to convert this value into the normal plane the formula changes to:

Chordal slot width (in normal plane without backlash) = pitch diameter × sin((slot width angle)/2) × cos(helix angle)

If the desired backlash normal to the flank surfaces is known, then this value can be divided by the cosine of the pressure angle to obtain the chordal backlash in the normal plane (Fig. 3):

Normal chordal backlash = (backlash normal to flank surfaces)/cos(pressure angle)

It is customary practice to add 50% of this value to the chordal slot width (without backlash) to obtain the chordal slot width at the reference circle (= pitch circle in case of zero profile shift). The chordal slot width is used to calculate the point width of the tool. 50% of the backlash is considered in the pinion tool and 50% in the tool of the mating gear.

In the normal plane, a standard profile has an addendum, which is 1.0 × normal module. The dedendum is 1.0 × normal module plus the clearance. A customary clearance is e.g. 0.2 × normal module. As a result, the whole depth of the example helical gear teeth is 2.2 × module. If there is a profile shift factor X unequal to zero and/or a depth factor unequal to 1.0, then the addendum and dedendum are calculated using the formulae below:

Addendum = normal module × (depth factor + X)

Dedendum = normal module × (depth factor + clearance factor – X)

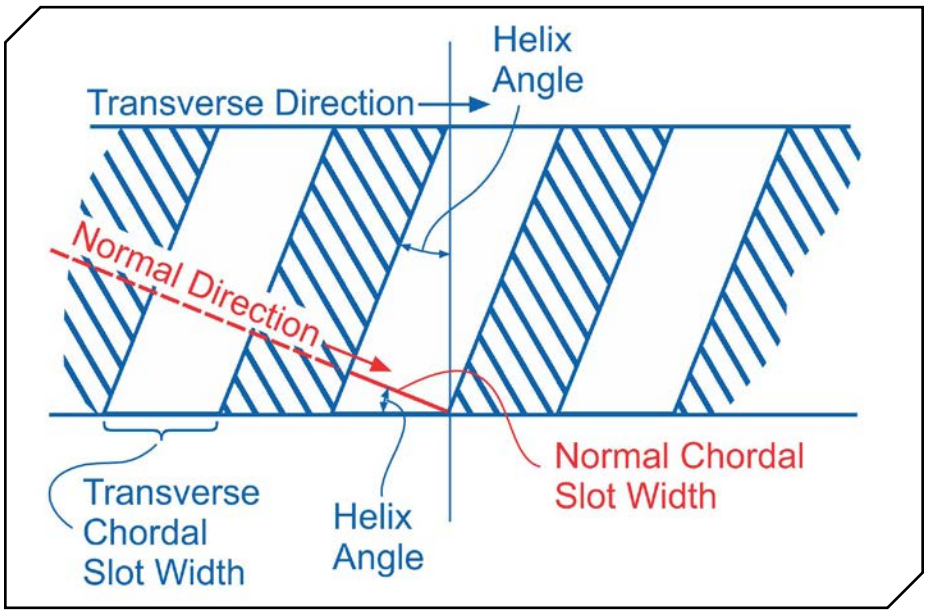


Figure 1 Transverse and normal direction.

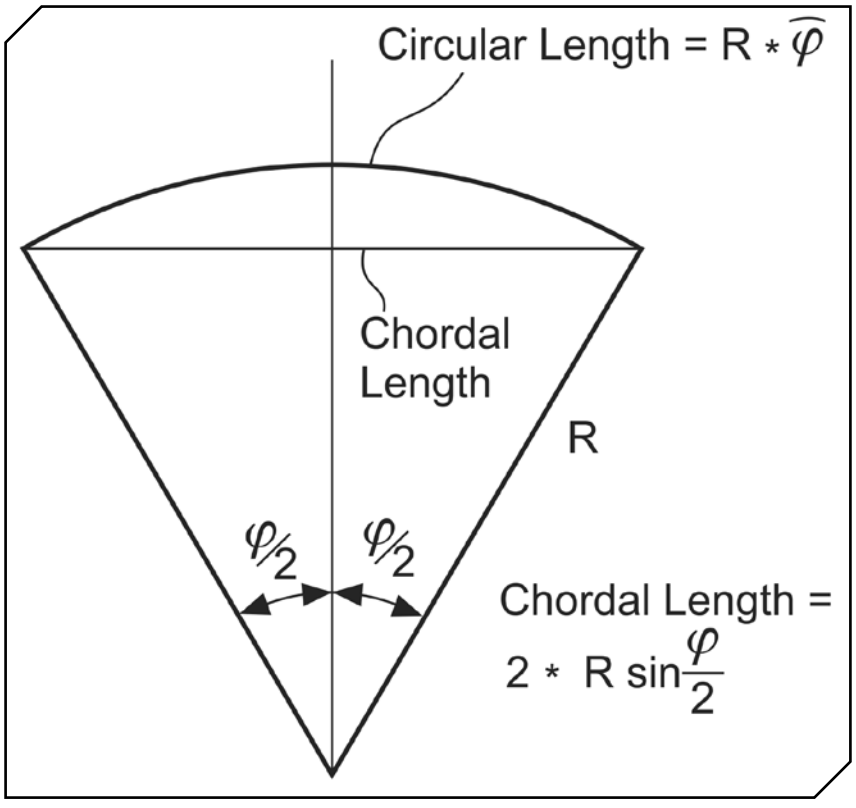


Figure 2 From circular and chordal dimension.

Whole depth = addendum + dedendum (= 2.2 in case of $X = 0$ and depth factor = 1)

The initial backlash number may be defined as a linear dimension normal to the flank surface (see above). If a tooth is in contact with a mating tooth, then the adjacent flank of the same tooth shows a gap to its mating tooth (Fig. 3). If a tooth is rolled from the beginning of meshing to the end, then the smallest gap is the smallest normal backlash. This backlash value is the normal distance between two flanks at the tight spot. Under no conditions during the operation of a gearset must the minimal backlash become zero. Zero backlash breaks up the lubrication film and can cause surface failure, depending on speed and load.

The minimal backlash is officially defined at the operating pitch circle of a gear. In case of no profile shift (or a *V*0 shift, where $X1 = -X2$) the operating pitch circle is equal the pitch circle. If not otherwise specified, the backlash of helical gears refers to the backlash measured in a transverse plane. While the initially desired normal backlash could be measured with feeler stock which is slid between the two mating flanks at the operating pitch lines, the transverse chordal backlash can only be measured with an encoder connected to the gear (angular backlash) or with an optical displacement measurement.

For general comparisons the normal backlash should be converted into the transverse plane to a transverse backlash, which is accomplished by multiplying the normal chordal backlash with the cosine of the helix angle:

Transverse chordal backlash = (backlash normal to flank surfaces)/ cos(pressure angle)*cos(helix angle)

An interesting side bar is mentioning that the observation started in the transverse plane to obtain the generating rack dimensions for the tool design in the normal plane. Although numbers like module and backlash are different between transverse and normal plane, the addendum and dedendum will not change: A tooth profile which appears tall in the normal plane will show a stub tooth appearance in the transverse plane.

Summary

- Balanced slot width calculation begins in the transverse plane based on 360° divided by twice the number of teeth.
- The slot width arc is converted to a chordal width with the formula in Figure 2
- Then it is converted to the normal plane (Fig. 1)
- In the normal plane 50% of the backlash is added to the normal chordal slot width in order to define the tool proportions
- The normal chordal backlash is converted to the transverse plane for general comparisons with values from the standards or other gearsets.

Dr. Hermann J. Stadtfeld is vice president/ Bevel Gear Technology -R&D, Gleason Corporation, and longtime contributor to *Gear Technology* magazine.

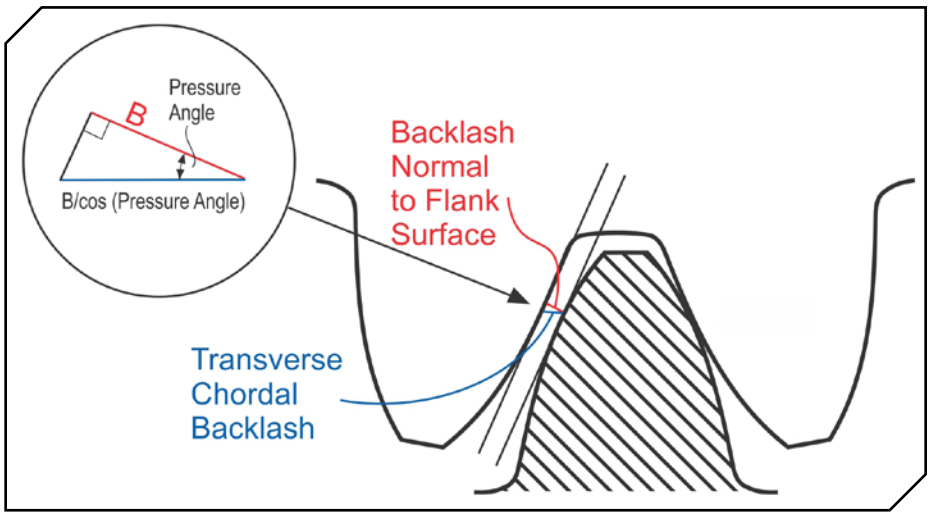


Figure 3 Backlash normal to flank and correlating transverse chordal backlash.

Transient EHL Analysis of Helical Gears

Dr. Hazim Jamali, Dr. Kayri J. Sharif, Prof. Pwt Evans and Ray W. Snidle

This paper describes a transient, elastohydrodynamic lubrication (EHL) model of involute helical gears and examines the extent to which their behavior can be approximated using both equivalent point and line contact steady-state approaches. Significant transient effects are found near the ends of the contact line — particularly at locations where tip relief is active. Different tip relief profiles considered show that high stress concentrations and poor lubricant films may be avoided with suitable profile choice. Finally, 3-D results of a preliminary evaluation of surface roughness effects on local contact stress and EHL film thickness are presented.

Introduction

This paper addresses the lubrication of helical gears — especially those factors influencing lubricant film thickness and pressure. Contact between gear teeth is protected by the elastohydrodynamic lubrication (EHL) mechanism that occurs between nonconforming contact when pressure is high enough to cause large increases in lubricant viscosity due to the pressure-viscosity effect, and changes of component shape due to elastic deflection. Acting together, these effects lead to oil films that are stiff enough to separate the contacting surfaces and thus prevent significant metal-to-metal contact occurring in a well-designed gear pair.

EHL analysis of simple spur gear contact can be achieved with a straightforward line contact analysis, assuming plane strain conditions. For a helical gear pair, however, kinematic and geometrical conditions vary along the contact line; and if crowning of the teeth is applied, point contact analysis is required. Conditions change continuously through the meshing cycle, so there is a transient effect that should be included in the analysis.

As the gears rotate, a line of contact moves across the teeth; in general, there is more than one contact occurring at any given time. The number of simultaneous contacts and their total length depends upon the basic gear parameters, principally the base helix angle β_b and the face width, F (Fig. 1). The lines of contact are limited at their two ends — either by their intersection with the side edges of the gear, or at the tips of the teeth. Both of these locations are potentially zones of high-contact stress concentration and associated EHL film thinning. To avoid premature tooth engagement, "tip relief" is usually applied and the gear teeth may be "crowned" so that the contact area becomes an elongated ellipse under load. The effect of helical gear tip relief has been considered by Kahraman and coworkers (Refs. 1–2), for example. This paper considers the EHL consequences of tip relief. Details of the analysis techniques are given (Ref. 3), where previous EHL studies of helical gears using various simplified analyses are reviewed. This paper provides results for a full 3-D EHL treatment that takes account of both transient and side-leakage effects based on the detailed geometry of crowned and tip-relieved teeth.

EHL Modelling of Helical Gear Contact

The EHL model for the contacting gear teeth is developed in the plane containing the contact line that is perpendicular to the common normal of the contacting teeth. This is referred to as the common tangent plane as (Fig. 1). It is perpendicular to the plane of contact, which is tangential to the base cylinders of both gears and contains the contact line at all contact positions of the gear pair. The motion of the gear tooth surfaces relative to the contact line takes place in the tangent plane and the lubrication mechanism must be considered with regard to axes *xyz* in Figure 1, where *z* is the common normal direction, *y* is the contact line direction, and *xy* is the common tangent plane.

The 2-D, non-Newtonian Reynolds equation relating lubricant pressure, p, and film thickness, h, is:

$$\frac{\partial}{\partial x}\left(\sigma_x\frac{\partial p}{\partial x}\right)+\frac{\partial}{\partial y}\left(\sigma_y\frac{\partial p}{\partial y}\right)-\frac{\partial(\rho\overline{U}h)}{\partial x}-\frac{\partial(\rho h)}{\partial t}=0 \quad (1)$$

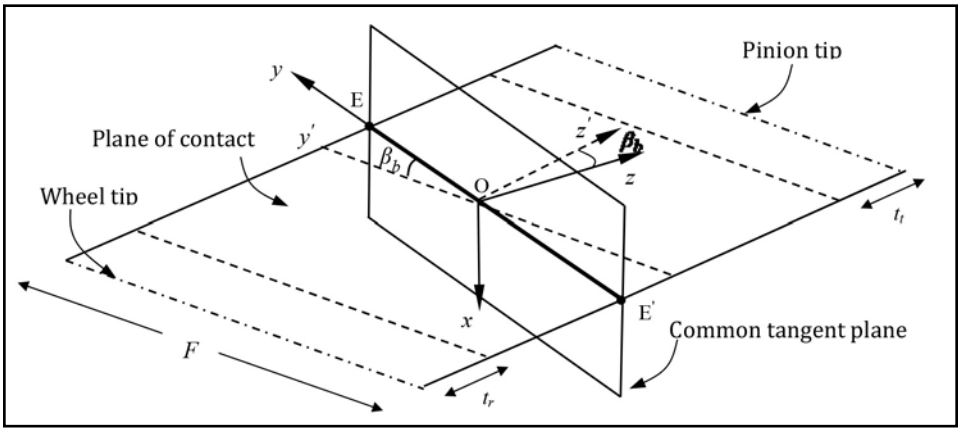


Figure 1 Plane of contact and common tangent plane intersecting on contact line EE' showing common normal direction, *z*, and tangent plane axes, *x* and *y*.

The lubricant entrainment velocity $\overline{U}$ is the mean velocity of the surfaces normal to the (y, z) plane, i.e. — in the x direction. The elastic deflection equation is written in a differential form (Ref. 4) as:

$$\frac{\partial^2 h(x_i,y_i)}{\partial x^2}+\frac{\partial^2 h(x_i,y_i)}{\partial y^2}=\nabla^2\left(h_u(x_i,y_i)\right)+\frac{2}{\pi E'}\sum_{all\,k,\,all\,l} f_{k-i,l-j}p_{k,l} \quad (2)$$

Where, $f_{k,l}$ are weighting factors for the effect of pressure on the film thickness Laplacian. The time-varying EHL problem described by Equations 1 and 2 is analyzed using the technique described (Ref. 4), suitably modified to include the variation of load, kinematic and geometrical conditions during the meshing

cycle of the gears. In Equation 3 the terms σ_x and σ_x are:

$$\sigma_x = \frac{\rho h^3}{12\eta} S_x \cdots ; \cdots \sigma_y = \frac{\rho h^3}{12\eta} S_y \quad (3)$$

Lubricant density and viscosity, ρ and η, are functions of pressure, and the non-Newtonian parameters S_x and S_y depend on h, η, $\partial p/\partial x$, $\partial p/\partial y$, and the sliding speed U_s.

To apply these equations to the gears, the un-deformed gap between the contacting surfaces is required to give $h_u(x,y)$ in Equation 2. This is obtained by considering the distance s from the pitch line to each point of the contact line measured in the direction of z, and establishing the local radii of curvature of the involute profiles that are used to obtain the un-deformed gap h_u. Microgeometry corrections, such as axial crowning (to prevent contact extending to the face boundaries and consequent edge effects and stress concentrations) and involute profile tip relief (to prevent premature engagement of the teeth under loaded conditions), are added to h_u (Ref. 3).

With helical gears, the motion is transmitted gradually and smoothly between the mating gears, as opposed to spur gears where contact occurs along a straight line parallel to the gear axis. Contact starts as a point at the tooth face end and, as the gears rotate, this extends to become a line increasing steadily in length (e.g., line EE′, Fig. 1) until it starts to contract, finally ending as a point at the other tooth face. This gradual engagement and disengagement leads to the gradual, even action of the tooth and distribution of load. The lines of contact act diagonally between the face ends of the teeth and there are at least two pairs of teeth in contact during the meshing cycle. These factors allow helical gears to have increased load capacity, compared with the corresponding spur gear drive.

Results

Pressure and film thickness contour plots for each position in the meshing cycle can be obtained from the transient analysis. The gear pair considered in this paper has module 4.5 mm, tooth numbers 33 and 99, pressure angle 20° and reference helix angle 19.6°. The gears have a face width of 44 mm with pinion tip diameter 166.61 mm, wheel tip diameter is 481.83 mm, and center distance 315.22 mm. The maximum length of the contact line during the meshing cycle is $w = 46.7$ mm. The meshing cycle is analyzed in 575 time-steps covering the mesh positions where the contact line exceeds $0.16w$. The pinion torque used for the analysis was 1.06 kNm with a rotational speed of 235.6 rad/sec. The analysis was isothermal with $\eta_0 = 0.00625$ Pas; pressure-viscosity coefficient $\alpha = 13.3$ GPa^{-1}; and non-Newtonian shear thinning parameter $\tau_0 = 10$ MPa.

In the middle third of the meshing cycle the contact lines extend from one face to the other and the conditions are similar to those seen in an elliptical EHL point contact with a high-contact aspect ratio. In this case the contact dimensions in the y and x directions are in the ratio of about 75:1. A characteristic horseshoe-shaped restriction is seen in the film thickness contour plot at the exit to the Hertzian zone and the pressure distribution is essentially Hertzian.

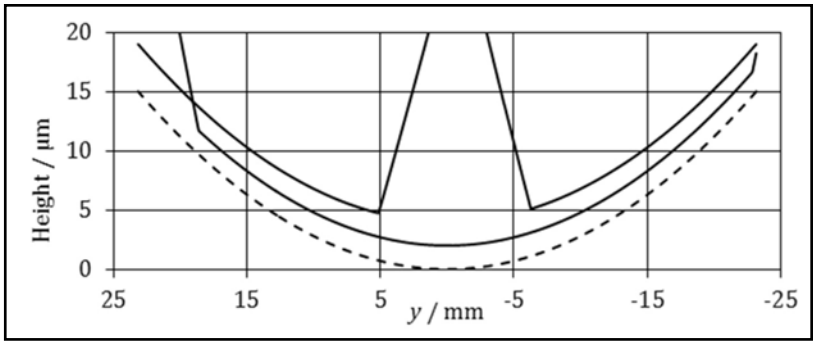


Figure 2 Gap between gear surfaces (offset) along contact line at positions 1, 2 and 3 in the meshing cycle with axial crown shown broken.

During the first part of the meshing cycle the effective contact line is limited by the tip relief profile applied to the wheel tooth, and during the latter part it is limited by the tip relief profile applied to the pinion tooth. Figure 2 illustrates the zero load gap between the tooth surfaces along the contact line at three meshing cycle positions.

Mesh positions 1, 2 and 3 are at time-steps 75, 300, and 500, respectively. In the figure the zero load gaps are offset by 2 or 4 µm for clarity. For position 2 it is clear that the gap is given by the axial crown, with the pinion tip relief becoming apparent for $y > 20.9$ mm. The tip relief profile illustrated in Figure 2 is linear. For position 1 the contact is essentially limited by the wheel tip relief at $y < 5.4$ mm, and for position 3 it is limited by the pinion tip relief for $y > -5.6$ mm. For positions 1 and 3 the combination of the axial crown and the active tooth relief leads to contacts that are curtailed at the onset of tip relief position where a significant stress concentration emerges in the calculations.

In all of the contacts there is a zone where the transient EHL result is essentially the same as the steady-state result for the geometry and kinematics at that position. This is illustrated in Figures 3, 4 and 5 for the three mesh positions that show sections of pressure and film thickness in the rolling/sliding direction. The figures show the steady-state 3-D results as solid lines and the transient results as broken lines. The equivalent 2-D line contact result is shown as a dash-dot curve for the sections where the transient and 3-D steady-state results are very similar.

The sections shown in Figures 3(a) and 3(b) show considerable differences between the transient and steady-state analyses in the vicinity of the tip relief profile modification. The pressure sections are almost identical, but the film thickness shows that the squeeze film terms in the Reynolds equation are active,

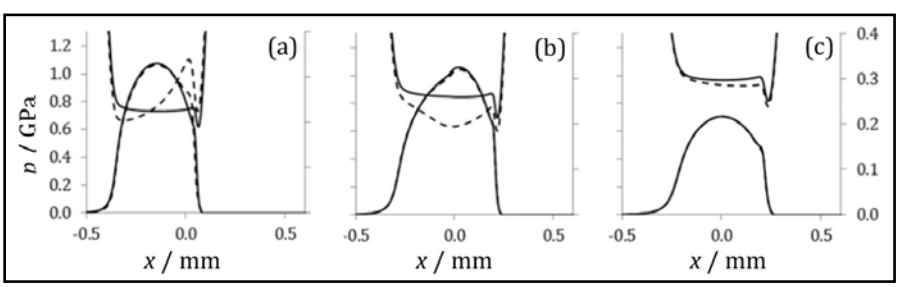


Figure 3 Pressure and film thickness sections at mesh position 1 for (a) $y = 2$; (b) $y = 5$; and (c) $y = 12$ mm.

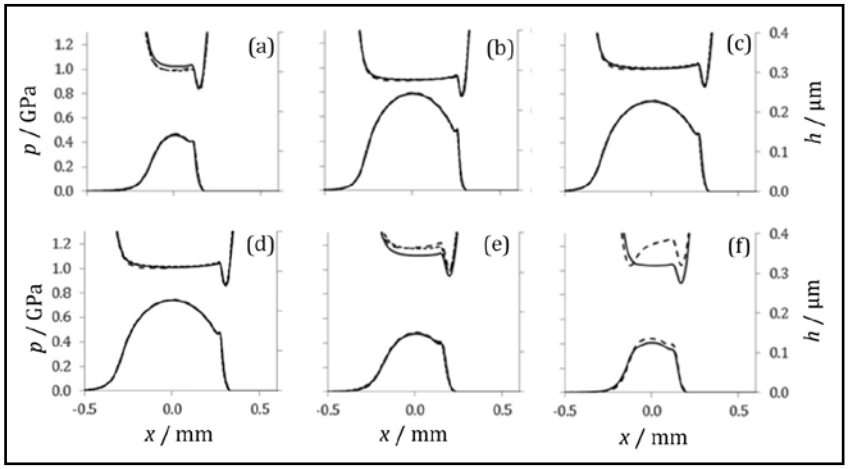


Figure 4 Pressure and film thickness sections at mesh position 2 for (a) $y=-18$; (b) $y=-10$; (c) $y=0$; (d) $y=10$; (e) $y=17$; and (f) $y=18$ mm.

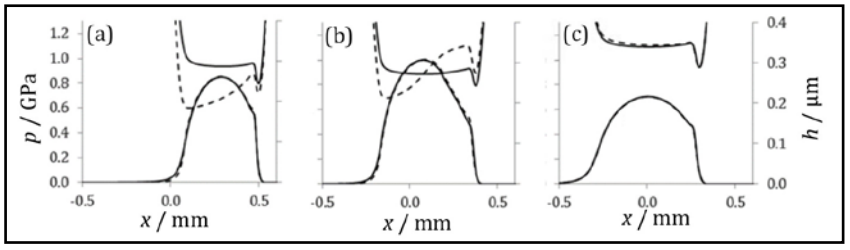


Figure 5 Pressure and film thickness sections at mesh position 4 for (a) $y=-2$; (b) $y=-5$; and (c) $y=-10$ mm.

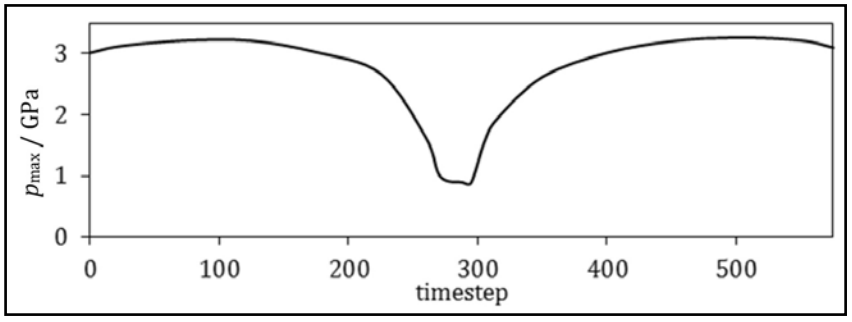


Figure 6 Maximum pressure obtained in each time-step for the case of linear tip relief profile.

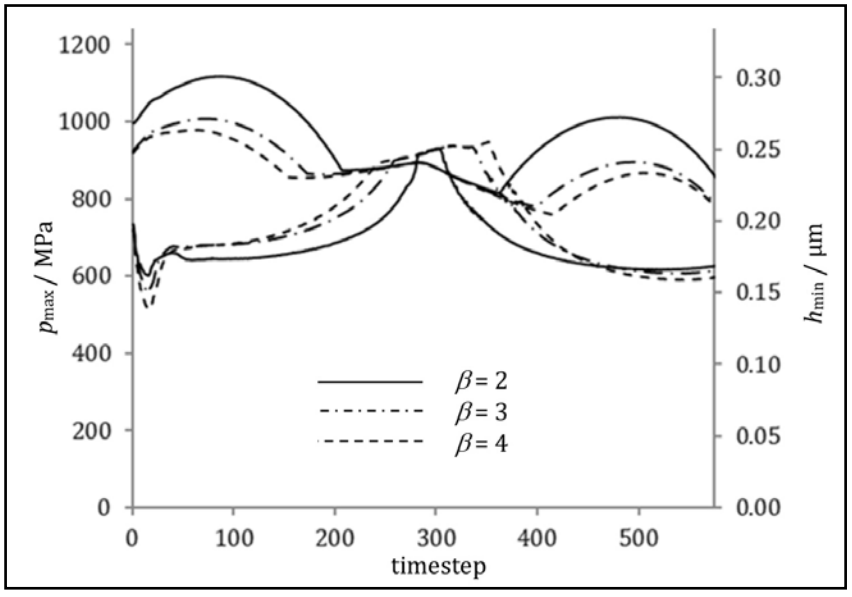


Figure 7 Maximum pressure (upper curves) and minimum film thickness (lower curves) over the meshing cycle

causing significant differences in the lubricant films. For Figure 3(c), which is typical of the rest of the contact line, the transient and steady-state results are very similar, showing that the squeeze film term is not influential when away from the tip relief position.

Figure 4 shows that in mesh position 2, the contact behaves in the same way as its steady-state counterpart for most of the contact length, with the only significant transient effects being seen in the film thickness profile of Figure 4(f), where squeeze film effects are active at the location of active tip relief. For sections 4(a) to 4(e), equivalent 2-D line contact analyses are also included that can be seen to show the same behavior.

Figure 5 shows results that are similar to those for Figure 2 in that steady-state behavior is apparent in Figure 5(c), which is representative of most of the contact line, with significant transient effects in Figures 5(a) and 5(b) that are in the vicinity of the tip relief profile modification. Again, the pressure sections are almost identical, with significant film thickness differences due to squeeze effects.

Figure 6 shows the maximum pressure obtained during the meshing cycle when the tip relief profile adopted is linear. The gears are operating at a nominal maximum Hertzian pressure of about 0.9 GPa, and it can be seen that during full contact width operation this is representative of the maximum pressure experienced. However, during the parts of the meshing cycle where the tip relief profile limits the length of contact, very high pressures of up to 3.5 GPa are experienced and the fluid film is unable to completely separate the surfaces (Ref. 3).The high-pressure levels are due to the stress concentration caused by the tip relief profile. This is discussed (Ref. 3) where the nature of the tip relief profile was varied by including a parabolic transition between the involute profile and the linear tip relief so that the slope of the tooth flank remained continuous.

In the current study the tip relief is taken to be in the form of the power law

$$z_t = c_t\{(r - r_{start})/(r_t - r_{start})\}^{\beta} \quad (4)$$

where r is the radius from the gear axis, r_{start} is the start of tip relief radius, r_t is the tip radius, and c_t is the profile removed at the tip. The value of parameter β is varied between 1 and 4, where $\beta = 1$ corresponds to the linear profile.

Figure 7 shows the variation of maximum pressure and minimum film thickness over the meshing cycle for values of $\beta = 2$, 3 and 4. The maximum pressures are reduced by a factor of three or more when compared to the result for $\beta = 1$ (Fig. 6). The value of β can be seen to have a significant effect on the peak pressures and also on

the minimum film thickness experienced in the contact. The pressures are further reduced for the higher β values, but these are minor additional changes.

Figure 8 shows film thickness and pressure contours at time-step 75 for the range of powers β specified for the analyses. For the linear profile $\beta = 1$, the maximum pressure contour is 3.2 GPa and the minimum film thickness contour is zero, indicating that the lubricant film is unable to separate the surfaces. This extreme behavior is not seen with the cases where $\beta = 2$, 3 and 4, where the minimum film thickness contours are around 0.185 µm and the maximum pressure contour values are 1.1, 1.0 and 0.96 GPa, respectively.

Figure 9 shows the contact line pressures for each time-step assembled into a contour plot for each of the tip relief profile forms considered. For the $\beta = 1$ case, intense closed contours for 3, 2 and 1 GPa appear at the top and bottom of the pressure map. The y axis is aligned with the contact line and the peak pressure contour indicates that the highest pressures occur at the start of tip relief positions, on the wheel at the bottom left of the contour plot, and on the pinion at the top right. For the higher values of β these contours become much less intense and the peak contact line pressure levels approach those occurring at the peak load full face width contact lines.

For the parts of the contact lines that operate in steady-state mode, a 3-D line contact analysis has been developed that allows consideration of the surface roughness present on both helical gear surfaces (Ref. 5). This analysis uses fast Fourier transforms (FFTs) to evaluate the surface deflection due to the pressure distribution (i.e., the last term of Eq. 2) and exploits the aliasing error introduced by the finite discrete FFT to consider a rectangular x-y solution space where x is the rolling/sliding direction, and y is in the direction of the contact line. Representative surface roughness profiles are introduced that are subject to periodic flow boundary conditions at the transverse, y, boundaries. The resulting solution corresponds to a line contact with surface roughness that is repeated periodically in the y direction. This enables the representative roughness to be extruded, either in the contact line direction (Fig. 11) or at appropriate inclinations to the contact line, which is currently a work in progress.

Figures 10 and 11 show results from 3-D line contact analyses. Figure 10 considers smooth surfaces extruded in the y direction The Hertzian line contact dimension for the case presented is 0.25 mm, and tests were carried out to establish the appropriate y dimension for the 3-D model to give the correct 2-D line contact result. It was found that using a y dimension of 1 mm or more yields 3-D results that are identical to the 2-D result. Smaller values of the y dimension give 3-D results that vary in the y direction.

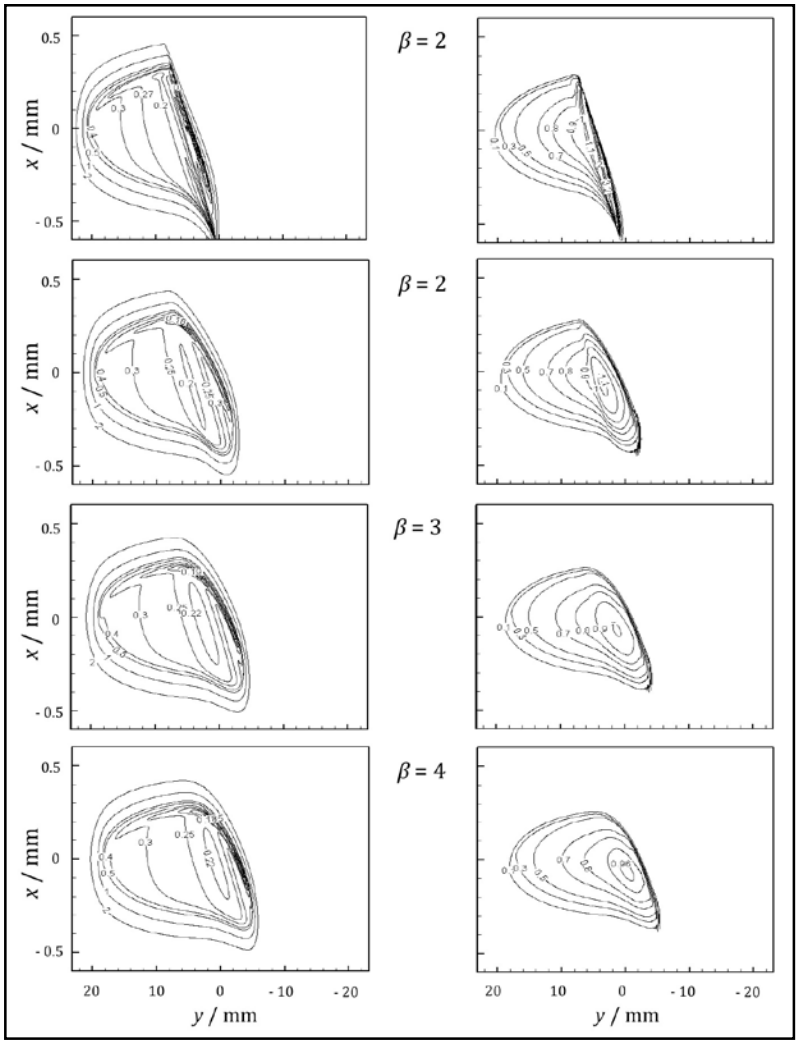


Figure 8 Film thickness contours/µm (left) and pressure contours/GPa (right) at timestep 75 for the four values of β.

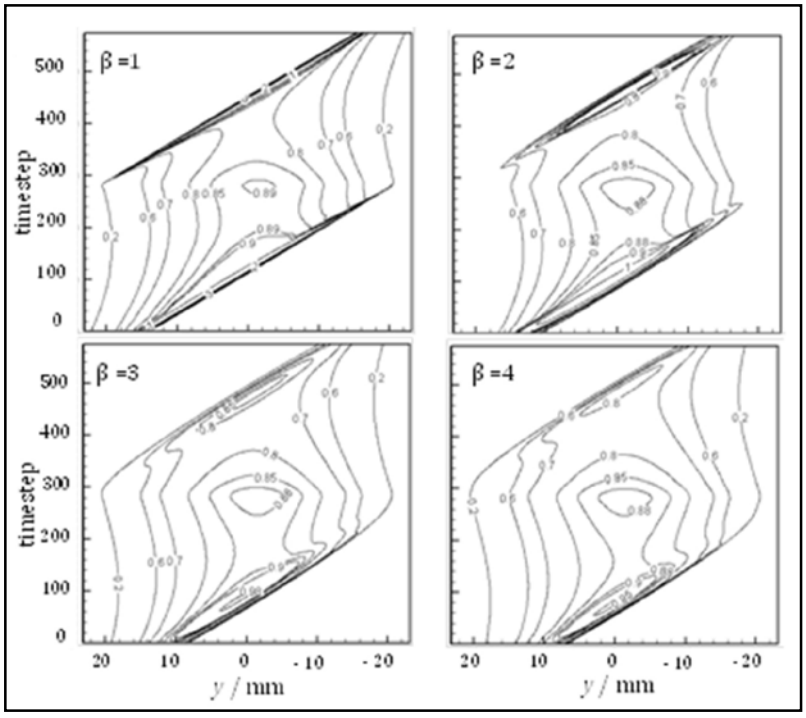


Figure 9 Contours of contact line pressure/GPa for the four values of β.

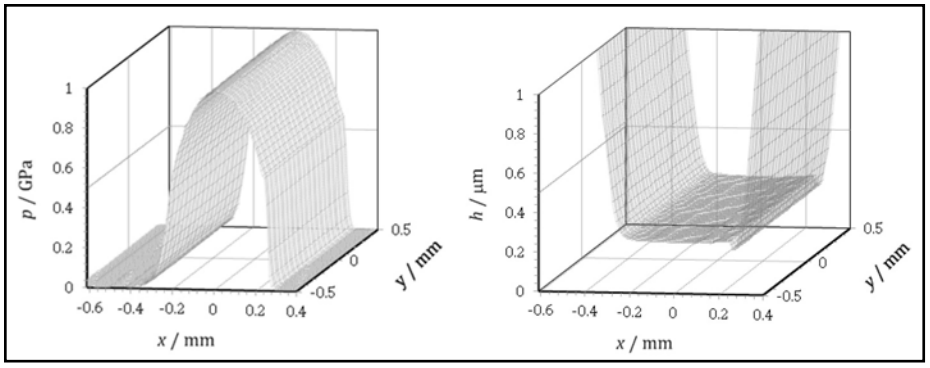


Figure 10 Pressure (left) and film thickness (right) results for a 3-D line contact with smooth surfaces.

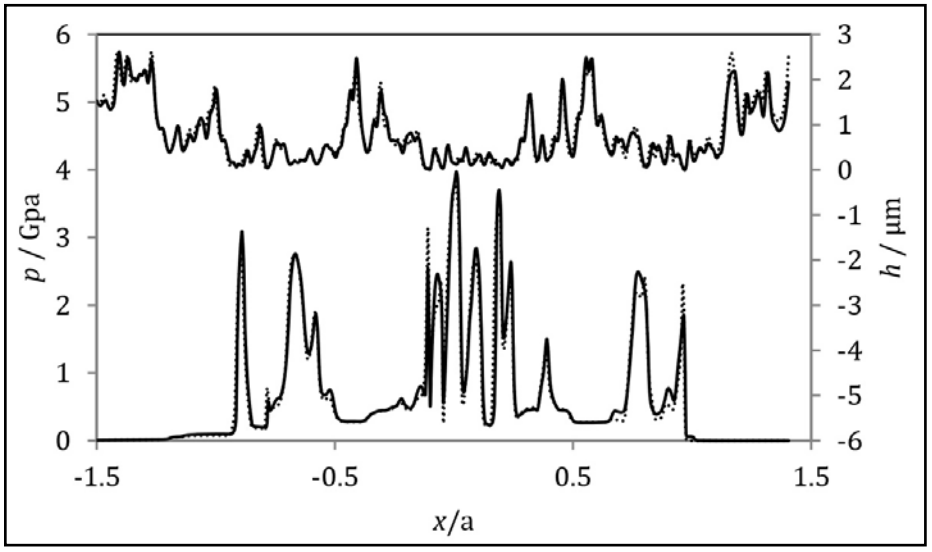


Figure 11 Pressure (lower curves) and film thickness (upper curves) for a time-step for 3-D (solid) and 2-D (dashed) analyses with rough surfaces.

Figure 11 compares the results for a single time-step from a 3-D transient line contact analysis with two rough surfaces whose roughness profiles are extruded in the *y* direction. The line contact analysis is presented with dashed lines that can be seen to replicate the 3-D analysis almost exactly. This approach can therefore be used to examine the effects of surface texture in helical gears. It is important to note that the boundary conditions applied must allow transverse flow at the limits of the model in order to properly represent the EHL flow in the helical gear contact, which was not the case in (Ref. 5). This limits the textures that can be considered to those consistent with applying periodic normal flow boundary conditions at the transverse boundaries.

Conclusions

Comparison of transient EHL analyses for the whole tooth contact with steady-state analyses using the instantaneous tooth geometry and kinematics show that transient effects are limited to the areas close to the ends of the contact lines where contact is limited by tip relief. For the bulk of the load carrying area the gears considered can be approximated by a sequence of steady-state analyses. Furthermore, for the areas that behave in this way, the aspect ratio of the contact is such that a line contact analysis gives the same pressure and film thickness response.

The tip relief profile adopted is very influential in determining the maximum pressure experienced by the gear flanks. Linear relief profiles lead to a significant stress concentration, together with extremely adverse film-forming conditions at the transition between the involute and relieved profile. This is because the linear tip relief introduces a slope discontinuity in the form of a cusp to the tooth geometry. However, these effects can be limited provided that the material removal to provide tip relief does not introduce a slope discontinuity.

A 3-D line contact approach is discussed as a means of introducing a surface texture that is periodic in the contact line direction into the EHL model.

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Innovative Steel Design and Gear Machining of Advanced Engineering Steel

Lily Kamjou, Patrik Ölund, Erik Claesson, Joakim Fagerlund, Garry Wicks, Mats Wennmo and Hans Hansson

The basis for high-fatigue performance in high-hardness steel originates in precise inclusion engineering. In addition, recent research shows that by changing the alloying strategy, an increase in the bending fatigue limit can be achieved similar to that of adding another shot-peening process. This paper describes the potential of clean steel for new approaches in transmission gearbox manufacturing and possibilities to meet the future demands for smaller, lighter and managing higher torque. An important factor is the bending fatigue performance of gear teeth where increasing fatigue strength is required. The paper discusses how shot peening might be eliminated in high-cleanliness, as-carburized steel components using an alternative composition. The full benefit of this new steel design can be obtained by using a high-quality steel with a decreased number of critically sized inclusions in the loaded volume. To address potential machining issues of clean steels, the paper also deals with the production process, including quantitative machining trials and the importance of tooling selection. The study is focused on the production of gears—primarily with turning and hobbing. Initial results show how these clean steels can be machined in full scale production in standard conditions with equal or better efficiency and cost.

Introduction

The increasing demands in the automotive industry for weight reduction, fuel efficiency and a reduced carbon footprint need to be addressed urgently. Up until now, widely used conventional steels have lived up to expectations. However, with more stringent emissions standards, demands on materials are increasing. Materials are expected to perform better, resulting in a need for increased fatigue strength. A possibility to increase torque on current generations without design changes can be achieved by selecting suitable materials.

With current and future generations of transmissions evolving towards higher loads as well as weight reduction, the material needs to support the step changes taking place, instead of limiting them. Better performing materials that can handle the higher stresses mean that loads on gear materials could be increased from 30% up to or above 100%, depending on the starting point, therefore providing new design opportunities. Today, single- and double-peening are methods frequently used to increase the fatigue strength for this type of loading. To meet increasing demands however, making use of the inherent potential of materials with improved intrinsic fatigue properties appears to be a natural way forward to handle the step changes taking place (Ref. 1). And with an innovative steel design, costly and undesirable processing steps, such as shot peening, might even be eliminated.

Steel parts need to keep going virtually forever as well as meet new regulatory requirements. When selecting the right steel quality for highly loaded applications, it is not always easy to know all the functional properties and the cost and quality implications. It is important that suitable test and inspection methods are used to verify that the material fulfills the desired requirements. More precise methods, compared to the commonly used international standards, should be

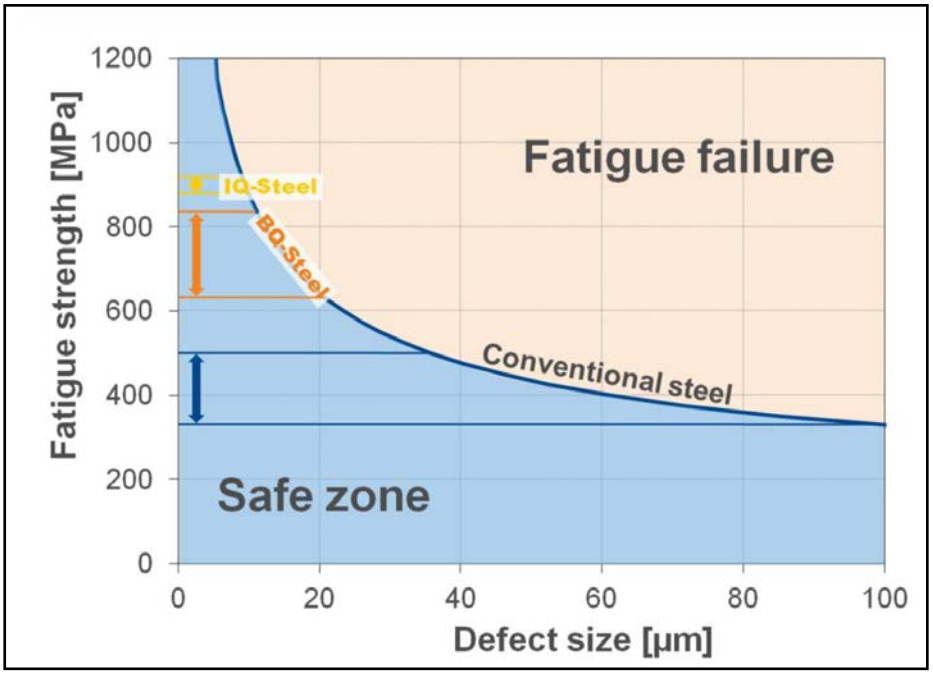

Figure 1 Relation between defect size and fatigue strength.

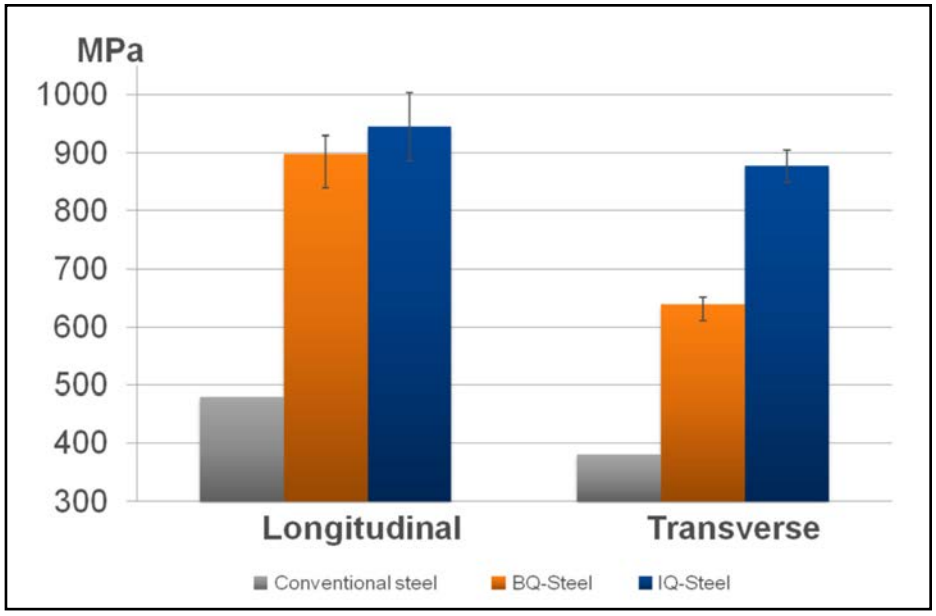

Figure 2 Rotating Bending Fatigue of conventional steel compared to BQ-Steel and IQ-steel in both longitudinal and transversal direction.

applied. In fact, such methods are already implemented for steel in highly stressed diesel injection components.

When moving from conventional steel to advanced engineering steel (clean steel), production issues like machining and tooling selection also need to be addressed before implementing material to production.

How Steel Cleanliness Affects Material Life

From experience, it is known that defects such as nonmetallic inclusions can initiate fatigue failures. Over the years, Ovako has focused on fatigue research and has now built up an impressive database of fatigue data. Steel quality has a huge impact on the fatigue life of a steel component. A clean steel that contains smaller sized defects compared to a conventional steel gives longer fatigue life.

Improvements in steel cleanliness result in big design opportunities. That is good news for any designer who has relied on old standards, when in fact modern steel practices have opened up for a new level of performance. Because of the properties of Bearing Quality steel (BQ-Steel) and Isotropic Quality steel (IQ-Steel), which now close the gap to re-melted steels, it is possible to downsize gears, bearings, and other steel parts to meet new requirements. For instance, a gearbox can be made lighter, with higher power density, by using cleaner steel.

BQ-Steels are a range of high cleanliness steels with reduced defect size. The effect of reduced inclusion sizes in BQ-Steel could make it possible to improve design life and/or increase torque on existing generations of end-user systems. Moderate design changes can also be made while securing high and consistent quality level for the end-user products. Moving to BQ-Steel is normally the first step when upgrading from conventional steel.

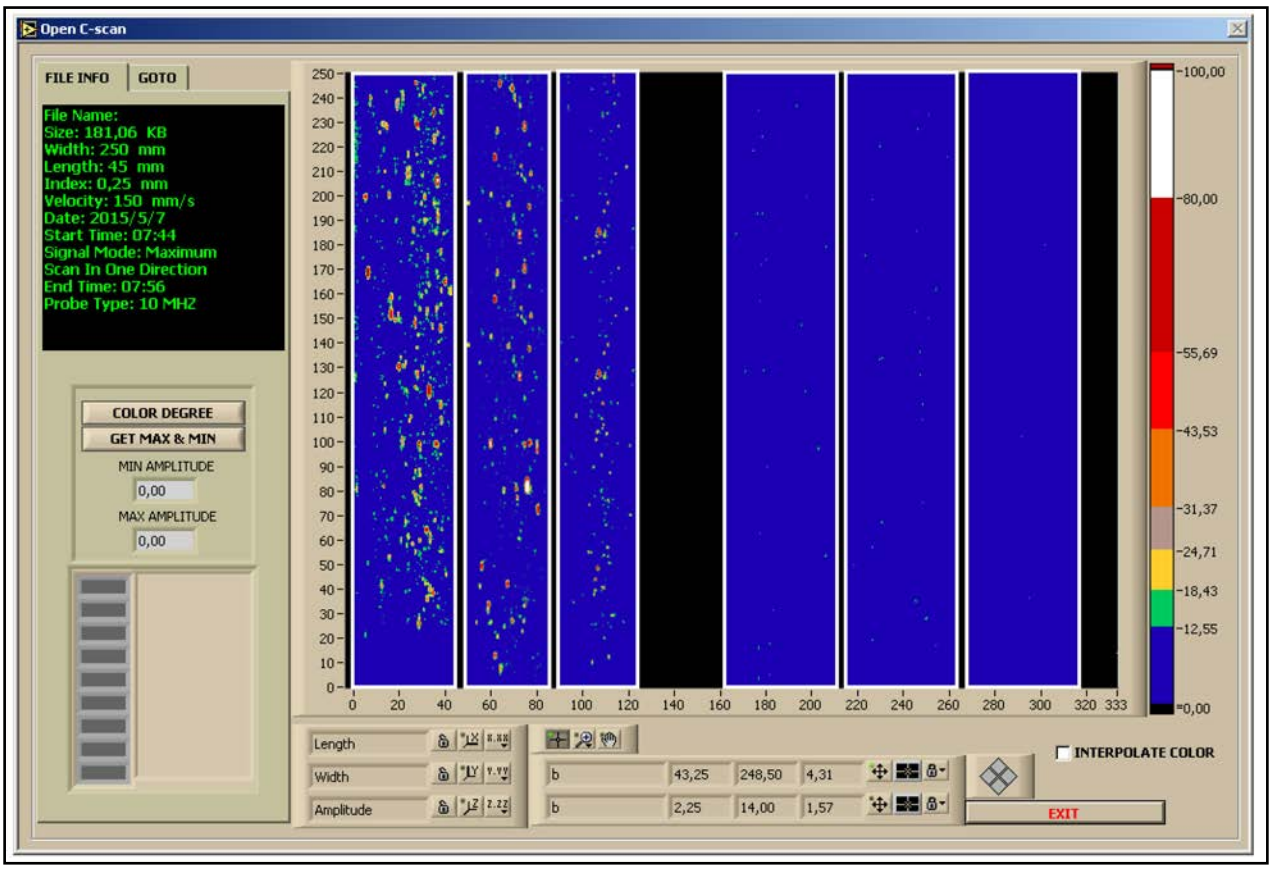

Figure 3 10MHz ultrasonic scans of six different steel samples from round bar ~ 70 mm.

IQ-Steels are a range of isotropic, clean steels, designed to have small and isolated inclusions and with a cleanliness comparable to re-melted steels. The small and evenly sized inclusions create the isotropic properties that can withstand heavy loads in all directions and therefore makes it suitable for complex load cases, such as those in gears.

In Figure 2, results from rotating bending fatigue testing show how different types of steel handle cyclic loading in both the normally loaded longitudinal direction as well as the transverse direction. Depending on loading mode, both BQ-Steel and IQ-Steel offer an improvement compared to conventional steel.

It is worth noting the typical sulphur content in the different types of steel mentioned in Figure 2. For conventional steel, a sulphur content of 200–400 ppm is quite common, whereas for a BQ-Steel, the sulphur content will typically be around 80–100 ppm. To achieve the desired properties of ultra-clean steel such as the IQ-Steel, the sulphur level has been reduced even more and is typically around 10 ppm.

Verifying Steel Properties

As has been shown, steel cleanliness is crucial when it comes to fatigue performance of high hardness steels; therefore, it is important to quantify the cleanliness in order to verify required fatigue performance of the final component (e.g., gear). Traditionally, macro-inclusions have been quantified by methods such as step-down testing and blue fracture testing. However, these methods give little or no information in regards to cleanliness, even for conventional steels of today.

For micro-inclusions, methods routinely used today, such as those found in ASTM E45, also give a very vague picture of the steel cleanliness, due to the small investigated area. For commonly used steels in the transmissions industry today, 10 MHz ultrasonic testing has been proven to be a relevant testing method. This method has the advantage of being able to inspect a fairly large volume in a short period of time, instead of investigating only a small area. In Figure 3 below, examples of ultrasonic testing on bars with a diameter of ~ 70 mm are shown.

Here, six samples have been evaluated by 10 MHz ultrasonic testing; the three samples to the left are typical carburizing steels used for gears in the transmissions industry today, and the three samples to the right are typical for clean carburizing steels (for example 20MnCr5) from the Ovako ingot route. The reason for the clearly visible difference between the different steels is how they are produced; the Ovako steel has an oxygen content of around 8 ppm, whereas conventional steels have oxygen content in the range of 8–30 ppm. Another important factor is the reduction ratio, which is much larger from this ingot route; commonly used conventional steels from continuous cast routes have a reduction ratio in the range of 8–25.

However, 10 MHz ultrasonic testing is not an accurate enough method to separate the clean steels of today, due to inadequate resolution; in order to improve the resolution, higher frequency can be used.

Alloys for Gear Applications

The development and investigation of a modified gear application steel was initiated a number of years ago by a transmissions producer. Due to the current climate and changes in the automotive industry, this topic is now high on stakeholder agendas. A number of different studies have been performed; so far, all investigations point to this specific material showing very interesting properties in the as-carburized condition — meaning shorter production processes and the possibility of reducing or eliminating process steps.

Gas carburizing is a widely used process to enhance the properties of highly stressed components. Typically, case carburizing will create compressive residual stresses and a tough core. However, a disadvantage of the carburizing process is that the near surface of the components can exhibit poor structure and tensile stresses due to oxidation of alloying elements that reduce fatigue endurance. Therefore an additional process — such as shot peening — is often introduced to change the stress state on the surface from tensile to compressive. This increases the bending fatigue strength significantly, but also tends to degrade the surface quality, which can in turn lead to other failure modes such as surface pitting. In some applications fine grinding is introduced to improve the surface properties. However, since it is difficult

Table 1 Typical chemical composition of Ovako 158Q compared to conventional steel for gear applications

	C	Si	Mn	Cr	Ni	Mo
Conventional 16MnCr5	0.18	0.10	1.30	1.25	0.15	0.04
Ovako 158Q	0.18	0.04	0.25	0.35	2.20	0.65

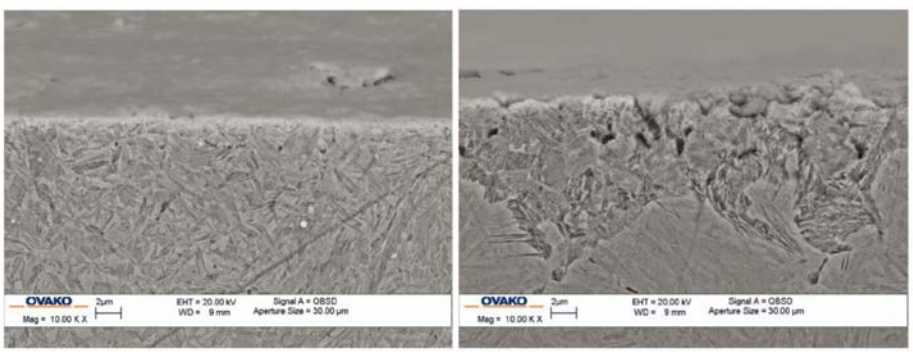

Figure 4 SEM micrographs of surface microstructure for Ovako 158Q (left); conventional 16MnCr5 (right).

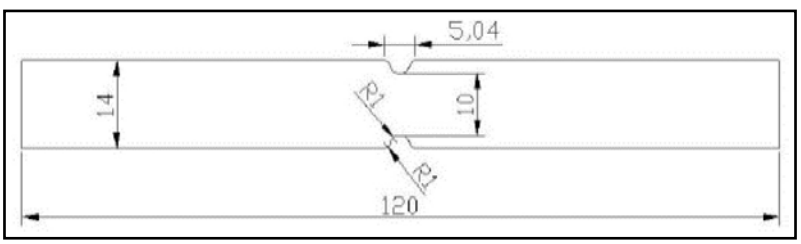

Figure 5 Notched specimen geometry for RBF testing.

to grind and get the necessary properties in the root, subsequent shot peening is applied as well.

By using a different approach in the selection of the alloying elements, a steel — i.e., one that exhibits a dramatically reduced tendency for the formation of internal oxidation during conventional gas carburizing — can be produced. Silicon, manganese and chromium, the elements responsible for internal oxidation, have been reduced as much as practically possible, while yet maintaining the steel's hardenability by increasing the content of nickel and molybdenum (Table 1).

The result is a steel with a martensitic microstructure all the way to the surface, and thus the residual stresses remain compressive at the surface. Figure 4 shows the difference between a conventional gear steel and the 158Q in the as-carburized condition.

Fatigue Performance

To evaluate the fatigue performance of Ovako 158Q for as-carburized gear components, a thorough fatigue test program has been conducted. Rotating bending fatigue (RBF) tests, pulsator testing on gears, and surface fatigue testing in FZG-test rigs were performed.

Rotating bending fatigue tests were then conducted on a notched specimen to simulate the highly stressed root area of a gear tooth (Fig. 5).

The specimens were tested in an as-carburized condition with a fully reversed loading, i.e. — R = –1. The runout criteria were set to 107 cycles, and the applied load was changed according to the staircase test strategy.

Results of the RBF testing clearly indicate that Ovako 158Q exhibits an increase in the fatigue limit of >20%, compared to a conventionally used steel such as the 16MnCr5 (Ref. 2); (Fig. 6).

Bending fatigue testing done in pulsator testing rigs on gears shows similar results (Refs. 3–4), which verifies the reliability of RBF testing.

Contact Fatigue Testing

Gears made out of Ovako 158Q have been tested at the Royal Institute of Technology (KTH) in Stockholm to establish how this type of steel compares to conventional steel.

The tests were performed in an FZG back-to-back gear test rig with a pitting test set-up according to the FVA standard for pitting (Refs. 5–6), and in a first trial run at load stage 10. The gear profile with modified C-Pt geometry is common for this type of testing, although the tip relief is slightly altered. The gears have been produced through turning, gear cutting, case hardening, hard turning (inside) and grinding. No shot-peening has been performed on either material.

Before each test the gear case was flushed twice and a new gear pair cleaned and inspected for rust or any other damage, then mounted, loaded with the run-in load and the oil level set correctly and heated to 90°C. The gear pair was then run-in for four hours at a pinion torque of 94 Nm (corresponding to load stage 5), which corresponds to a maximum Hertzian pressure of 0.92 GPa at the pitch. Once the running-in was done, the test rig was loaded to the test load of 372 Nm for the pinion (load stage 10), corresponding to a maximum Hertzian pressure of 1.84 GPa at the pitch. Pitting failure in these tests is defined as having pitting over 4% of the flank, i.e. — 5 mm^2 of the C-Pt gears.

For the reference material, the results varied broadly. This is probably related to a larger scatter in inclusion sizes that can be found in the reference material, combined with the surface conditions of these gears. For the gears made out of 158Q, the testing was stopped after 300 hours as defined by the test procedure (Table 2). Table 3 shows the number of contacts of the pinion at the maximum pressure of 1.84 GPa.

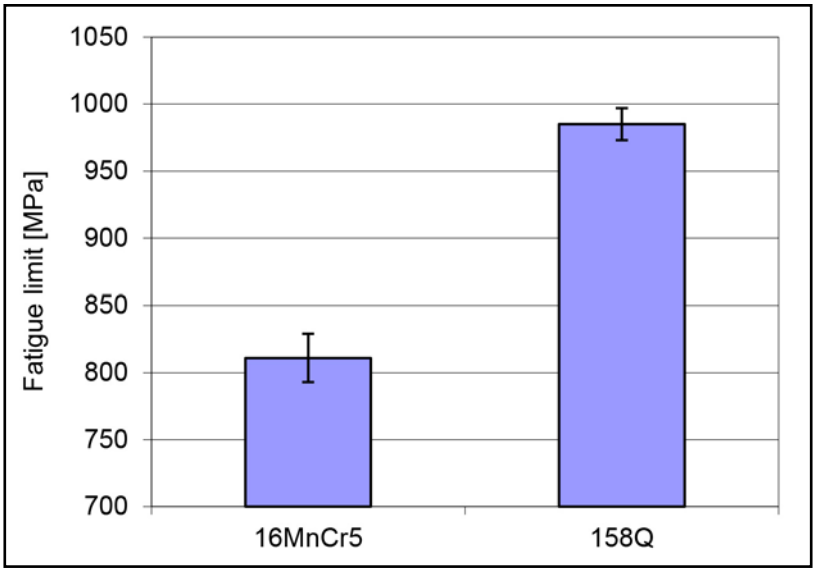

Figure 6 Fatigue limit for notched RBF samples of Ovako 158Q and reference 16MnCr5.

Table 2 Run time for first test set

	Test 1, run time	Test 2, run time	Test 3, run time
Ref material (16MnCr5)	169h	118h	300h (run-out)
Ovako 158Q	300h (run-out)	300h (run-out)	300h (run-out)

Table 3 Number of hours and contacts for both steel types

Number of hours	**118**	**169**	**300**
Number of contacts of pinion	15e6	21.9e6	39.0e6

Machining Clean Steel

The aim of the machining trial was to understand how advanced engineering steel behaves in standard machining processes in comparison to conventional steel commonly used in gears. For this purpose the two steels tested were Ovako 158Q and a conventional 20NiCrMo2-2. Since the general consensus is that the sulphur content is one of the parameters affecting machinability, it is worth noting the sulphur content of the two materials; Ovako 158Q with an S-content of typically around 10 ppm, and 20NiCrMo2-2, with an S-content typically of around 200–400 ppm.

As a step in determining what impact clean steel will have on the total cost of production, quantitative trials have

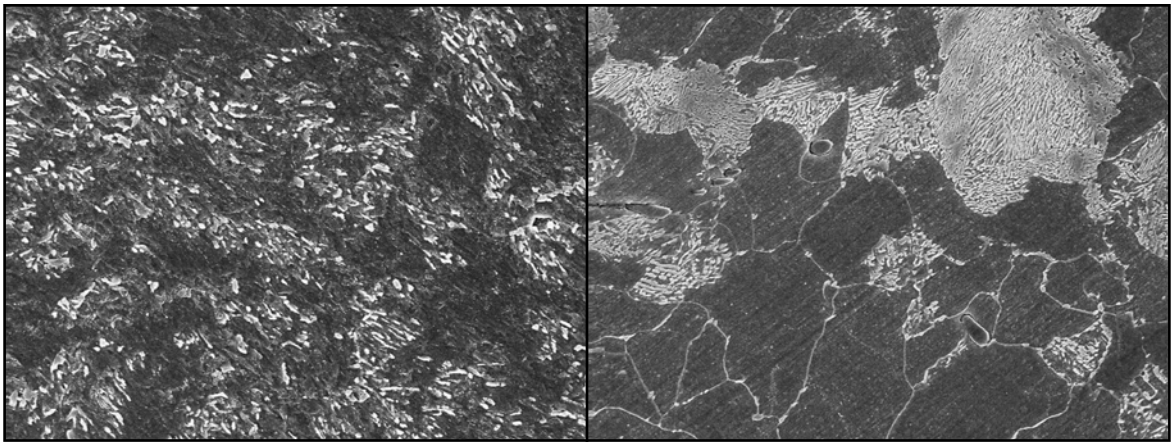

Figure 7 Microstructure photographed in SEM ×2,500 magnification; Ovako 158Q (left); reference material, 20NiCrMo2-2 (right).

been performed to support machining of this type of material. The key is optimization — i.e., finding the right set-up for this type of steel. It has been shown through testing done in collaboration with manufacturers of powertrain components and tooling, that producing gears according to current processes (such as turning and hobbing) can be achieved with cost neutrality, or in some cases even at a reduced cost. Simply by changing tool inserts to a more modern technology, clean steels machine just as well as, if not better than, conventional steels. One important factor is the consistent quality of the material; that variation, delivery to delivery, is very low. Correspondingly, ensuring a more advantageous microstructure than the uneven but standard ferritic perlitic structure, together with smaller inclusions that don't interfere in an adverse way, leads to a stable machining process.

Table 4 Material data

Material	Weight of blank (kg)	Weight after turning (kg)	Hardness (HB)	Inserts	Number of turned parts
20NiCrMo2-2	1.4	1.05	162	GC4325	404
Ovako 158Q	1.29	1.05	192	GC4325	404

Testing Procedure

The initial machining trials were based on the standard set-up at the transmissions component producer. The machinability test was carried out in ordinary production machines for a planetary gear, which in serial production is made from a forged blank of a steel close to the standard 20NiCrMo2-2. Gear data is $z = 20$, modulus = 3.7 mm, and the same cutting data as in serial production was used for both materials.

The forged blanks in 20NiCrMo2-2 showed a ferritic/pertlitic structure (Fig. 7, right).

The blanks in Ovako 158Q were cut from a rough-turned bar with a dimension close to the forged blank. The diameter was somewhat smaller compared to the forged blank, resulting in a slightly lighter blank. The structure was ferritic with cementite (Fig. 7, left).

Turning Trials

The weight of the blanks after turning was 1.05 kg, thus 0.35 kg was turned away from the reference material and 0.24 kg was removed for Ovako 158Q (Table 4). In serial production with forged blanks for reference material, the normal output is 290 gears-per-insert-tip — using insert tip type GC4225. By changing to a different insert type — insert type GC4325 with unidirectional crystal orientation — this number could be increased substantially. In the test 404 parts were turned with each insert tip for both types of material before the machining was stopped and the inserts analyzed. At that point the inserts had not yet reached their lifetime; the test was stopped before run-out.

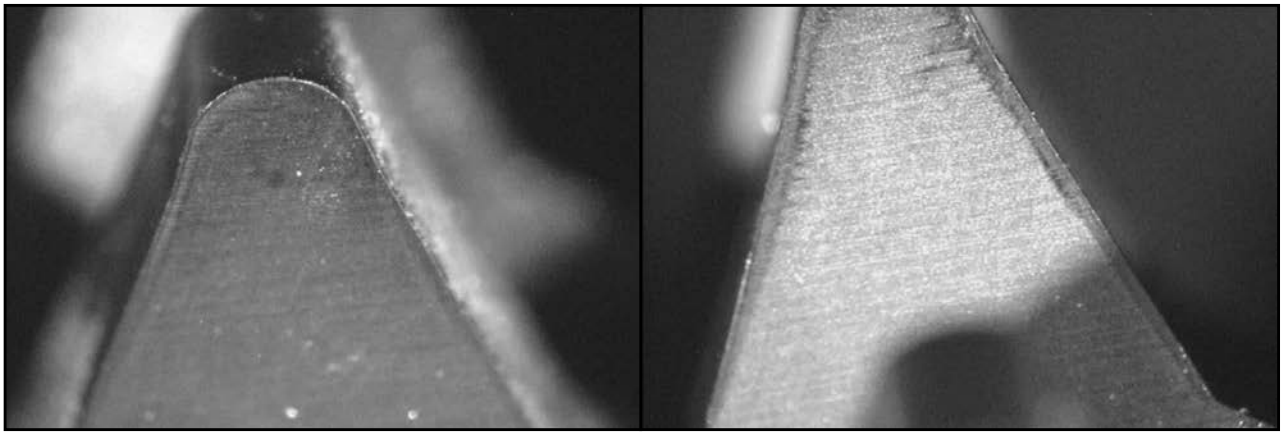

Figure 8 Hob tooth after 300 gears (magnification 30×) Ovako 158Q (left); reference material (right).

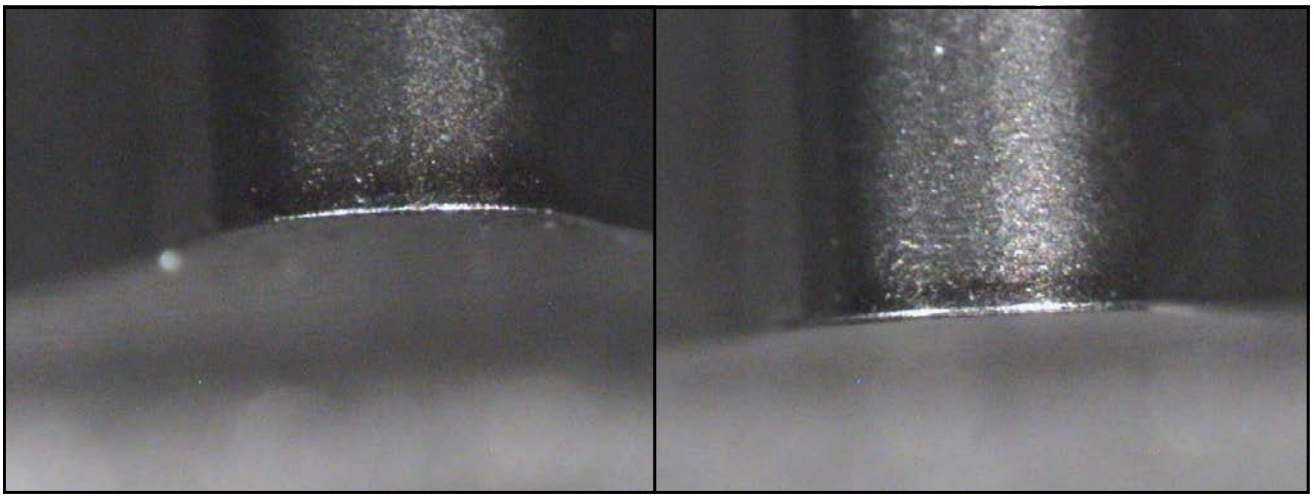

Figure 9 Hob tooth after 300 gears (magnification 63×) Ovako 158Q (left); reference material (right).

Gear Cutting Trials — Hobbing

A PM-HSS hob in S390, coated with Alcrona, was used for the test. The hob was sectioned in three parts with 35 mm effective shift distance for each section, in a dry hobbing process. Cutting speed was 150 m/min, and axial feed was 3.5 mm/rev with maximum chip thickness of 0.2 mm.

An increased hob temperature of 5–10°C was noted for Ovako 158Q, compared to the reference steel. The actual gear temperature for Ovako 158Q was measured to be 3°C warmer. The hob teeth were analyzed in a light optic microscope, but no significant difference in wear could be detected after the same number of parts was hobbed (Figs. 8 and 9).

The equivalent cutting length for each hob tooth was 9 m, which is considered to be very good.

Conclusions

It has been shown that by alloy design alone, the level of internal oxidation resulting from a ten-hour gas carburizing cycle can be reduced to less than 2µm. The steel grade 158Q with a reduced tendency to form internal oxidation shows an increase in fatigue limit of a minimum of 20%, when compared to commonly used conventional steel grades.

Machining trials for clean steel show a very similar behavior to conventional steels, regarding turning and gear cutting in a production set-up.

The results of the machining trials are the first part of two quantitative studies. The second part, which is now underway, will hopefully provide more conclusive data in this area. So far, optimization of the production processes appears to be the key.

One important factor to take into consideration is of course microstructure. As mentioned for the machining trials, the microstructures of the two tested materials were different: one — more commonly found in the automotive industry — ferritic perlitic structure, and one ferritic with cementite. The fact that microstructure and material cleanliness play an important role in machining processes is supported by studies made by Swerea Kimab, an institute for applied research within the materials field (Refs. 7–8).

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MPIF

ANNOUNCES AWARD-WINNING POWDER METAL PARTS

The winners in the 2016 Powder Metallurgy (PM) Design Excellence Awards competition, sponsored by the Metal Powder Industries Federation (MPIF), amply demonstrate PM's capabilities in their own ways. They focus on PM's strong points to gain and extend their competitive advantage, push production capabilities and process tolerances to their very limits, and bring originality to the conception of what is possible through creative design.

Grand Prize Awards

The Grand Prize in the Automotive — Transmission Category was awarded to GKN Sinter Metals, Auburn Hills, Michigan, for five components — a side gear, two pinion gears, a locking side gear and a locking plate — comprising a forged PM electronic locking differential gear set made for Ford Motor Company. The parts go into the rear axle differential of the Ford F-150 light truck, the first time forged powder metal differential gears have been used in such an application.

The Grand Prize in the Automotive — Chassis Category went to Keystone Powdered Metal Co., St. Marys, Pennsylvania, for seven components — rake cam, left-hand inner cam, retainer guide, right-hand rake teeth energy-absorbing eccentric strap cam, column mounting insert teeth and left-hand rake teeth — made for its customer Nexteer Automotive. The heat-treated diffusion-alloyed steel components are all part of the steering column in the Chevrolet Colorado and GMC Canyon trucks.

The Grand Prize in the Aerospace/Military Category was won by Advanced Forming Technology, an ARC Group Worldwide Company, Longmont, Colorado, for a front sight base. The MIM-4605 low-alloy steel part is used on the AR-15 rifle. The front sight base, made by metal injection molding (MIM), is much larger than the typical MIM part and has a complex geometry.

The Grand Prize in the Medical/Dental Category was won by Parmatech Corporation, Petaluma, California, with four stainless steel MIM components — articulation lock bar, articulation connector, articulation drive block and knife guide — used in an articulating endoscopic surgical device designed specifically for thoracic surgery.

ITAMCO's Joel Neidig

RECEIVES AGMA 2016 NEXT GENERATION AWARD

Joel Neidig, an engineer and lead technology developer with ITAMCO, has received the 2016 Next Generation Award from the American Gear Manufacturers Association (AGMA). This award, presented annually since 2011, recognizes innovative work by an individual responsible for one or more significant achievements through his or her effort and work that has

enhanced or strengthened the gear industry and/or AGMA. This award honors individuals who are emerging as contributors, innovators and leaders in the gear industry and serves as an incentive for others in the next generation of gear industry talent. The award was presented May 13th at AGMA's Centennial Annual Meeting in Amelia Island, Florida.

The award is the latest in a series of milestones for Neidig and ITAMCO to acknowledge their efforts to transform their precision machining facilities into "smart factories." ITAMCO is part of a research group that recently received an Applied Research and Development award from the Digital Manufacturing and Design Innovation Institute. The group is developing a platform that will integrate every piece of software, hardware and equipment from its accounting program to its machine tools. ITAMCO was chosen as the implementation site because many of their machine tools are already connected to the Internet and each other through MTConnect. "We are only 12 to 15 months away from a totally integrated shop floor. A job will be entered into our ERP system and then every piece of the job, from allocating materials, to man-

ufacturing, to shipping and invoicing, will be routed through the entire facility. Machines will be chosen based on the type of work and availability. And the platform is dynamic—if a machine goes down, the job will be automatically rerouted," said Neidig.

Mitutoyo America

OPENS RENOVATED M3 SOLUTION CENTER

Mitutoyo America Corporation recently announced the grand opening of the newly renovated M^3 Solution Center in City of Industry, CA. This nearly 35,500-square-foot facility is conveniently located for customers to schedule appointments for product demonstrations, assistance with application challenges and metrology solutions, as well as product and educational training seminars. The M^3 Solution Center is located at 16925 East Gale Avenue, City of Industry, CA 91745. "Our goal is to provide relevant and timely metrology solutions to our customers, in a region that is home to aerospace, defense, medical and general machining industries. In updating our M^3 Solution Center, we're providing our customers with industry-leading technology and training all under one roof," says Jeff Thompson, Western regional sales manager.

GMTA

PROVIDES SAMAG MACHINING CENTERS TO NORTH AMERICA

Now available from German Machine Tools of America (GMTA), a full line of Samag machining centers, including multi-spindle, horizontal machining centers, deep hole drilling machines and combination milling/drilling machines, is offered for the North American market.

Samag, based in Saalfeld, Germany with offices worldwide, engineers and builds a variety of multi-spindle machines, including the MFZ Series for large workpieces, the smaller, modular WBM Series for up to six spindle deep drilling and the combination TFZ Series, which offers users the ability to bore and mill complex cubical workpieces on four sides with a single clamping. On the largest standard machine, large scale mold-making is possible, with a maximum drilling depth of 2,300 mm (over 90"), 65 mm (over 2-1/2") bore and a 50-ton capacity worktable.

The company also supplies complete turnkey operations, including robotic articulation, parts handlers and transfer

mechanisms for high-production work such as connecting rods and complete machining of differential housings.

GMTA Vice President Scott Knoy comments, "This new partner dramatically expands our capability in the large block milling market. Plus, with deep drilling technology and the combination machine concepts, we will be able to offer significant advantages to our current and potential customer base. We're excited to have the Samag name and reputation for quality machine tools added to our family."

Schafer Industries

ACQUIRES CUSTOM GEAR AND MACHINE

Effective July 1, 2016, Schafer Industries, Inc., through its wholly owned subsidiary, Schafer Gear Works Rockford, LLC, has acquired the assets and business of Custom Gear and Machine, Inc. The acquisition was announced jointly by Bipin Doshi, president of Schafer Industries, and Stan Blenke, the company's executive vice president.The manufacturing facility includes a 50,000 square foot plant in Roscoe, Ill. producing gears and machined products for a variety of industries, including oil and gas, construction, mining, agricultural, power transmission and defense. Schafer owns and operates a similar facility in Rockford, Ill. The Rockford facility will be shut down by the end of August 2016 and all manufacturing and management functions will move under a single roof in Roscoe.

SCHAFER INDUSTRIES

According to Blenke, the purchase of Custom Gear and Machine, Inc. was an opportunity that aligned with Schafer's strategic objectives and its product mix to secure a stronger market position in all market segments served by the two companies. "For over 80 years, Schafer has been involved in providing gears nationally and internationally for many applications and customers. This acquisition, along with the combination of manufacturing and management functions, creates additional capacity and engineering capabilities to serve our existing customers as well as attract new customers," Blenke stated.

He went on to say that "combining our two engineering departments creates a stronger team to address complex issues in process development. It also enhances our ability to solve customer issues around reducing manufacturing costs and provides a best value option for their needs."

Solar Atmospheres

RECEIVES NADCAP 24 MONTH MERIT STATUS FOR HEAT TREATING

Solar Atmospheres of California recently announced that it has been awarded Nadcap 24-month Merit Status for Heat Treating. Solar has held Nadcap accreditation since 2011. Having demonstrated their ongoing commitment to quality by satisfying customer requirements and industry specifications, the Nadcap Task Group has determined that Solar Atmospheres of California has earned this special recognition. Instead of having their next Nadcap audit in eighteen months, Solar Atmospheres of California has been granted an accreditation that lasts until July 31, 2018.

"Achieving Nadcap accreditation is not easy; it is one of the ways in which the aerospace industry identifies those who excel at manufacturing quality product through superior special processes. Companies such as Solar Atmospheres of California go above and beyond achieving Nadcap accreditation to obtain Merit status and they should be justifiably proud of it," said Joe Pinto, executive vice president and chief operating officer at the Performance Review Institute. "Benefitting from a less frequent audit schedule reduces audit costs and associated pressures and demonstrates the trust that the aerospace industry has in Solar Atmospheres of California based on their past performance in Nadcap audits. PRI is proud to support continual improvement in the aerospace industry by helping companies such as Solar Atmospheres of California be successful and we look forward to continuing to assist the industry moving forward."

September 12–17—IMTS 2016 McCormick Place, Chicago, Illinois. The International Manufacturing Technology Show is one of the largest industrial trade shows in the world, featuring more than 2,000 exhibiting companies and 114,147 registrants. This year's show is expected to be one of the largest IMTS events at 1.3 million net square feet with a full line up of exhibitors showcasing the latest technology. Co-located shows include Motion, Drive & Automation North America, Industrial Automation North America, Surface Technology North America, Comvac North America and Industrial Supply North America. For more information, visit *www.imts.com*.

September 13–17—AMB 2016 Stuttgart, Germany. AMB 2016 has posted record figures for the previous event in 2014. The promotional supporters—the German Machine Tool Builders' Association (VDW) and the German Machine Tool and Plant Builders' Association (VDMA) with the Associations for Precision Tools and Software—contribute to this success. The exhibition areas of AMB Stuttgart comprise metal-cutting and metal-removing machine tools, precision tools, measuring systems and quality assurance, workpiece and tool handling technology, robots, industrial software & engineering, components and accessories. The exhibitors includes Chiron-Werke, DMG Mori Seiki, EMCO, GF Machining Solutions, Gühring, Hahn+Kolb, Ilg + Sulzberger, Index-Werke, Iscar Germany, KASTO Maschinenbau, Komet Group, LMT Tool Systems, MAPAL Präzisionswerkzeuge, Nagel Werkzeug-Maschinen, Paul Horn, Sandvik Tooling Deutschland and Yamazaki Mazak Deutschland, to name just a few. For more information, visit *www.messe-stuttgart.de*.

September 19–20—IHEA Seminars Cincinnati Marriott Rivercenter, Covington, KY. This Fall, the Industrial Heating Equipment Association (IHEA) is proud to offer the 47th Combustion Seminar, the ever-popular Safety Standards Seminar and the revised Induction Seminar. The concurrent seminars will be held along with a joint Tabletop Exhibition and Reception on Monday, September 19. The tabletop exhibition features companies from all the technologies represented throughout the three seminars. Registration fees for each seminar include all seminar handout materials, the Monday evening Reception with Tabletop Exhibition, and breakfast and luncheons on both days. Upon completion of the course, seminar attendees are awarded a certificate of completion. For more information, visit *www.ihea.org*.

September 19–21—2016 Gear Failure Analysis Big Sky, Montana. The Gear Failure Analysis seminar provides participants the skills necessary to diagnose gear failures and prescribe remedies. This presentation covers six classes of gear tooth failure: overload, bending fatigue, hertzian fatigue, wear, scuffing and cracking. Each failure mode is illustrated by color slides and field samples because of the magnification inherent in slide projection. However, it is important to examine the field samples because there is no substitute for hands-on experience that students experience. Working in small groups, students participate in a hands-on practical exam using field samples and a case study. Instructors include Robert Errichello and Jane Muller. For more information, visit *www.agma.org*.

September 19–23—2016 Basic Training for Gear Manufacturing Students learn the fundamentals of gear manufacturing in this classroom and hands-on course. In the classroom this course offers training in gearing and nomenclature, principles of inspection, gear manufacturing methods and hobbing and shaping. In the hands-on gear lab, using manual machines, students can see the interaction between the cutting tool and the workpiece. They understand the process and the physics of making a gear and can apply this knowledge in working with CNC equipment commonly in use. Although the Basic Course is designed primarily for newer employees with at least six months experience in setup or machine operation, it has proved beneficial to quality control managers, sales representatives, management, and executives. Instructors include Dwight Smith, Pete Grossi and Allen Bird. For more information, visit *www.agma.org*.

September 26–29—Gear Dynamics and Gear Noise Short Course Ohio State University. The purpose of this unique short course is to provide a better understanding of the mechanisms of gear noise generation, methods by which gear noise is measured and predicted and techniques employed in gear noise and vibration reduction. Over the past 37 years more than 1,950 engineers and technicians from over 360 companies have attended the Gear Noise Short Course. A popular feature of this course is the interspersing of demonstrations with lectures. The extensive measurement and computer software capabilities of the Gear and Power Transmission Research Laboratory allow instructors to do this in a simple and non-commercial manner. The Case History Workshop (Day 3) allows course instructors and participants to interact and to discuss gear noise and dynamics case histories presented by course attendees. Throughout the course, laboratory and computer software demonstrations are used to illustrate gear noise measurement and analysis techniques. The facilities of the Gear and Power Transmission Research Laboratory and the Acoustics and Dynamics Laboratory are used for these demonstrations. Course instructors include Dr. Donald Houser and Dr. Rajendra Singh. For more information, visit *www.nvhgear.com*.

September 26–28—MINExpo International 2016. Las Vegas Convention Center. MINExpo boasts 12 indoor and outdoor halls and more than 1,800 companies involved in the global mining industry. Opening sessions allow the industry to come together to debate global challenges, market fluctuations and the future of mining. 20+ education sessions will tackle the most timely and pressing issues in mining today. Resources include exploration, mine site development, open pit mining, underground mining, smelting and refining, processing and preparation and reclamation. Attendees will see live demonstrations they can use today and emerging technology for tomorrow. For more information, visit *www.minexpo.com*.

October 19–21—2016 Global Forecasting & Marketing Conference Miami, Florida. AMT strives to provide companies with the tools they need to expand their business. By bringing together leading industry experts, economic forecasts and marketing information, companies will have the resources they need to identify new opportunities and areas of growth in a dynamic, ever-changing market, positioning them as tomorrow's industry leaders. Knowledge of the current and coming economic environment, as well as the MT industry and its customers, both in the U.S. and globally, is the key to strategic planning. Those interested can gain this data and accompanying analysis by purchasing the Global Forecasting & Marketing Package (GFMP).For more information, visit *www.amtonline.org*.

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What Was He Thinking?

First U.S. Auto Race Was Held in Chicago — On *Thanksgiving 1895!*

Jack McGuinn, Senior Editor

Well. It seemed like a great idea at the time—to Herman Henry Kohlsaat.

Having read about an automobile race in France, Kohlsaat decided he'd host America's first auto race in Chicago. The year was 1895 and automobiles were still a great curiosity. Kohlsaat, owner/publisher of the *Chicago Times Herald*, planned to exploit the growing interest in motoring by sponsoring a 54-mile race from downtown Chicago to nearby suburb Evanston, Illinois, and back. The match was open to all comers, foreign or domestic, whether powered by gas, electricity, or steam. The top prize: $2,000 (that's 50,000 2016 dollars).

To draw a big holiday crowd Kohlsaat set the race date for Independence Day, 1895. But he quickly learned this was too soon for the entrants; they pleaded with Kohlsaat to delay the race so they could ready their vehicles for racing competition. So Kohlsaat delayed the race to Labor Day. As that date drew near, *again* the contestants pleaded for more time. Ultimately Kohlsaat scheduled the race for Thanksgiving Day, November 28. While optimistically hoping that fair weather would hold for the race, Thanksgiving Eve a storm blew in off of the lake and buried Chicago's streets in snow. High winds followed, with snowdrifts gusting across racecourse streets.

Come morning, only six cars made their way to the event's Jackson Park starting line. At 8:55 a.m., a small, shivering crowd watched the first vehicle set off. It was the only gas-powered American car in the contest and had been built by industry pioneering brothers Charles and Frank Duryea. The other three gas vehicles were all German machines built by Karl Benz — yes, *that* Benz — one representing the De La Verne Refrigerator Machine Company, one representing Macy's Department Store in New York, and the last driven by Oscar Mueller of Decatur, Illinois, who proved to be a tough adversary.

A Sturges Electric and a Morris & Salom Electrobat were the race's two electric entries. No steam models competed.

The six cars soon disappeared into the white-out. It being 30 degrees and seasonably windy on the lakefront, the crowd did likewise. With cars "racing" at 5 mph there would be nothing to see for 10 hours.

The vehicles struggled mightily up Lake Shore Drive, fighting the wind, ice and snowdrifts. As they passed Lincoln Park they were unexpectedly greeted by cheers from a crowd of thousands. But these weren't race fans; they were returning attendees from a football game between the University of Chicago and University of Michigan who noticed the horseless carriages slowly working their way up The Drive. Soon afterward, as Frank Duryea was crossing the Rush Street Bridge, the steering arm on his vehicle snapped. He managed to get his vehicle to a blacksmith's shop where the arm was repaired, but the delay put him an hour behind the leading Benz car.

In the late afternoon as the driver of the Macy's Benz tried to cut into Duryea's by then lengthening lead, he ran into a sleigh that had overturned in the street. He was able to extricate car from sleigh and motor on, but he then soon ran into a horse-drawn hackney cab, damaging the car's steering. The driver somehow managed to roll the car in between the trolley car tracks *and drive it to the next checkpoint*. Mechanics spent 80 minutes putting the Benz back in running order. But by 6:15, the darkening sky and cold winds were too daunting. The Macy's Benz vehicle dropped out of the race.

This left just Duryea and the other Benz — driven by Mueller.

Duryea had now been driving for nine hours and was experiencing ignition trouble and forbidding snowdrifts. In addition, *he'd taken a wrong turn that added several miles to his route*. But he was still ahead of Mueller, who had even greater problems of his own.

You see, before the race Mueller decided he would not just carry a referee, like all entrants were required — but an extra passenger as well. *Not* good strategy. After spending the day in the back of the car huddled against the freezing winds, the passenger was overcome by the cold. He had to be lifted out of the car and was then transported in a sleigh for medical attention. Mueller? He kept driving but he, too, was losing consciousness.

Six-thirty p.m. rolls around and Duryea is nearing the finish line. Kohlsaat wrote in his memoir, "Lacking spectators — except here and there a solitary workman on his way home — the men on (Duryea's car) gave vent to war whoops, cheers, catcalls, and other manifestations of joy over the victory they were winning." Not exactly a victory lap, but it would have to suffice. And at 7:18 p.m. Frank Duryea crossed the finish line — taking 10 hours and 23 minutes to travel 52.4 miles.

About two hours later, Mueller's Benz loomed into view. But now the referee was driving. In one hand, he held the steering tiller, and, in the other, he held up Mueller, who'd collapsed from exposure.

Chicago's Thanksgiving Day auto race did not become a holiday tradition. It's not that Chicagoans are afraid to spend hours standing in the cold for a sporting event — as countless Bears-Packers December contests demonstrate. As the *Chicago Tribune* declared on its front page that day, Thanksgiving was "The day we celebrate — the day when football and turkey rule." (*Source*: "The First Auto Race: Thanksgiving 1895," by Jeff Nilsson and H.H. Kohlsaat, *The Saturday Evening Post*, Nov. 26, 2015.)

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