

# gear

TECHNOLOGY<sup>®</sup>

SEP  
2012

# IMTS 2012

EVENTS, CONFERENCES, FUN STUFF

PREVIEW: CUTTING TOOLS,  
WORKHOLDING, ETC.

EXHIBITORS OF NOTE

IMTS.com

**TECHNICAL**

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Transmissions, Axles,  
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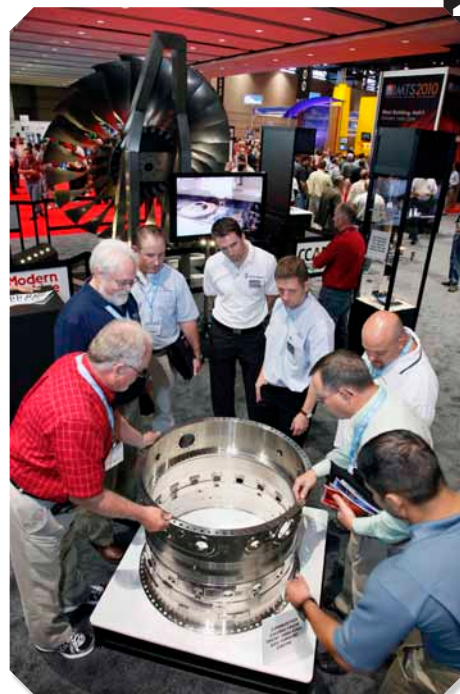
**Plan to see us at IMTS!**

<http://info.star-su.com/plan-to-attend-imts-2012>





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**Gear Industry Videos**

Visit [www.geartechnology.com](http://www.geartechnology.com) to see the latest gear-related videos, including a selection of IMTS previews from exhibitors at the show.



If you have a sharp eye, you may be able to spot publisher Michael Goldstein in this video from Sandvik Coromant, filmed during a recent gear manufacturing event at Sandvik's training center in Schaumburg, IL.



Broaching on a CNC mill-turn machine? See how it's done in this video from DMG/Mori Seiki and Seco Tools.

**Did You Know We Had a Newsletter?**

Every month, more than 10,000 gear industry professionals receive *Gear Technology's* e-mail newsletter, which includes exclusive content you can't find anywhere else. Fortunately, you can still read back issues of the e-mail newsletter at [www.geartechnology.com/newsletter](http://www.geartechnology.com/newsletter).

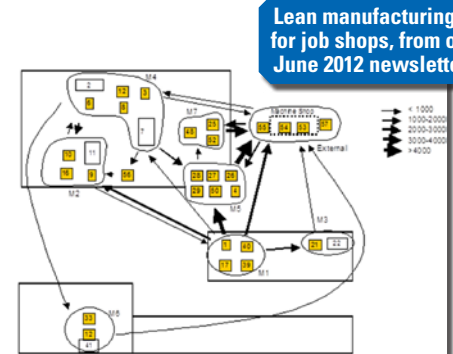
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In-depth comparison of forging and casting, from our July 2012 newsletter.



Lean manufacturing for job shops, from our June 2012 newsletter.

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RANDALL PUBLICATIONS LLC  
1840 JARVIS AVENUE  
ELK GROVE VILLAGE, IL 60007

(847) 437-6604  
FAX: (847) 437-6618

**EDITORIAL**

**Publisher & Editor-in-Chief**  
Michael Goldstein  
[publisher@geartechnology.com](mailto:publisher@geartechnology.com)

**Managing Editor**  
William R. Stott  
[wrs@geartechnology.com](mailto:wrs@geartechnology.com)

**Senior Editor**  
Jack McGuinn  
[jmcguinn@geartechnology.com](mailto:jmcguinn@geartechnology.com)

**Associate Editor**  
Matthew Jaster  
[mjaster@geartechnology.com](mailto:mjaster@geartechnology.com)

**Editorial Consultant**  
Paul R. Goldstein

**Technical Editors**  
William (Bill) Bradley  
Robert Errichello  
Octave Labath, P.E.  
Joseph Mihelick  
Charles D. Schultz, P.E.  
Robert E. Smith  
Dan Thurman

**DESIGN**

**Art Director**  
David Ropinski  
[dropinski@geartechnology.com](mailto:dropinski@geartechnology.com)

**ADVERTISING**

**Advertising Sales Manager**  
Dave Friedman  
[dave@geartechnology.com](mailto:dave@geartechnology.com)

**Materials Coordinator**  
Dorothy Fiandaca  
[dee@randallpublications.com](mailto:dee@randallpublications.com)

**CIRCULATION**

**Circulation Manager**  
Carol Tratar  
[subscribe@geartechnology.com](mailto:subscribe@geartechnology.com)

**RANDALL STAFF**

**President**  
Michael Goldstein

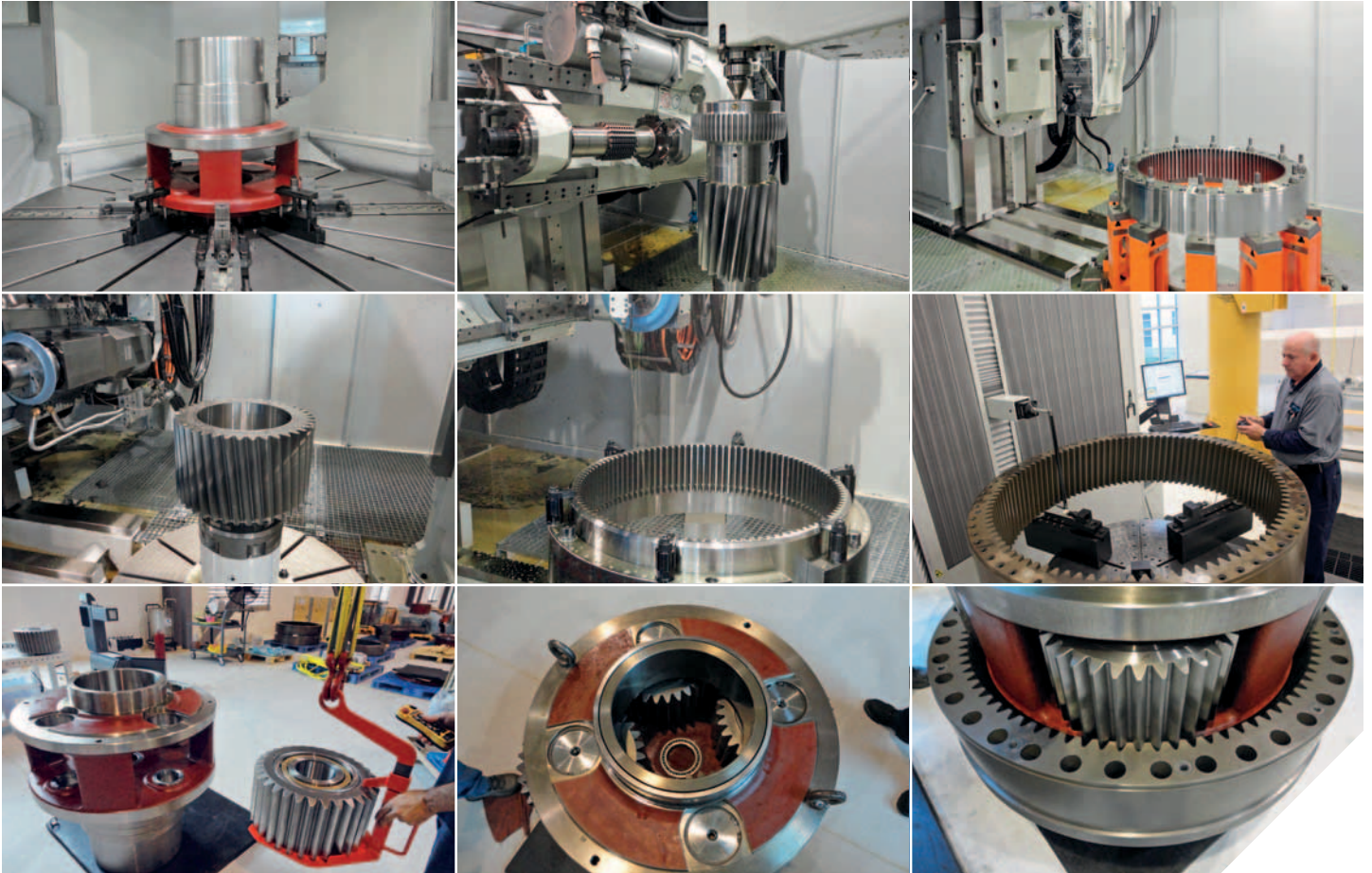
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IMTS BOOTH #  
**N-7046**



# AMERICA

## Needs a Different Kind of Candidate



**Publisher & Editor-in-Chief**  
Michael Goldstein

**The two candidates in the upcoming presidential election offer two distinctly different approaches to solving America's economic problems**— neither

of which is likely to be successful. One, trying to stay in office, increasingly looks to borrow even more money from our future in yet another effort to kick-start the economy. The other tells us that increasing taxes for the top 1% is not necessary, because if we leave them alone, they'll invest their way to our prosperity (as if they have all their money sitting around in cash and are just waiting to figure out where and when to invest it).

While this ideological fight is going on, the manufacturing community—although it's enjoying a strong business climate—continues to suffer from a severe shortage of skilled labor. Our society encourages young people to go to college—and for many, this is the right choice. But for too long we've been turning out too many lawyers, financiers and unneeded liberal arts majors. Parents need to get more involved and question the educational direction their kids are taking. Manufacturing isn't often considered a viable vocation, despite the fact that today there are possibly 600,000 manufacturing jobs available to the right candidates (according to the Manufacturing Institute).

Time and time again I read about manufacturers struggling to hire good candidates to support their growth, let alone to replace their present aging workforce. A recent article focused on the hiring woes of manufacturers in Northeast Indiana, where 26% of the workforce is employed in manufacturing. One hiring manager expects to go through 500 applicants just to get the 10 that he needs, and there's no guarantee that those 10 hires will work out. Another hiring manager took 129 applications, which he screened down to 40. Of those 40, only four passed the basic skills test. All four were offered jobs, but only one accepted. Applicants are failing drug tests and others decide they want to wait until their unemployment benefits run out before taking a factory job. Manufacturers hesitate to hire candidates with four-year college degrees out of fear that those candidates will leave as soon as something else becomes available.

We don't need better *political* candidates. We need better *job* candidates.

Just think of the economic benefits of 100,000 unemployed no longer drawing from the public coffers but each contributing \$35,000-\$70,000 a year throughout their communities and into our economic system and you can quickly see that our economic problems can be solved from the ground up much more easily than from the government down.

The good news is that attention is finally being paid to the issue of the skilled manufacturing labor shortage. In addition to articles in the mainstream press, various organizations are getting involved. One example is AMT—The Association for Manufacturing Technology, the organizers of IMTS. At this year's IMTS, there will be a special focus on the manufacturing labor shortage. **Booth W-200** will be home to the IMTS Jobs Center, where you can meet with professionals in manufacturing placement. In addition, the show will have the NIMS Student Skills Center, where all week long, students, educators and counselors will have a hands-on opportunity to explore careers in manufacturing. Finally, the show's IMTSedu booth (**N-6677**) will host a town hall meeting about the workforce shortage on Tuesday, Sept. 11, at 11:00 a.m.

Solving our hiring problems might take the next decade, but you can solve some of your manufacturing problems within the next week or so by visiting IMTS in Chicago from September 10–15. It's here at this show that you'll find not only the latest machines and technologies but the most productive automation available to help you meet your potential demand for your products while you struggle with increasing or enhancing your workforce.

One of the best ways to reduce your dependence on hiring is to make the most of the labor you have. The key to that is highly effective manufacturing technology and automation, which is exactly what you'll find at the show. Automation not only lessens the impact of our need for more employees, but it also reduces the labor content of our products and reduces the cost advantages of low-wage competitors. Despite our issues with finding skilled labor, American manufacturers remain competitive in the world because of their ingenuity, technology and innovation.

# Sicmat

## UTILIZES NUM CNC SYSTEM

A high-performance, 11-axis CNC system from NUM has enabled machine tool manufacturer Sicmat to create a gear honing machine that sets a new industry standard for post-hardening fine finishing. Using an innovative honing wheel with external teeth, and an ultra-precise application-specific CNC program developed by NUM, the Grono 250 machine provides the accuracy of gear shaving—but in a process that is applied after the gear has been case hardened—and eliminates the need for shaving and grinding stages.

Sicmat is a manufacturer of gear finishing machine tools for the automotive and automotive supply industries. Until relatively recently, the company specialized exclusively in machines that used shaving technology to obtain the necessary finish to gears; this type of finishing process is used extensively by companies producing medium- to high-quality gears for the automotive industry. However, shaving generally has to be performed before the workpiece is case hardened by heat treatment, and any heat-induced deformation



The Grono 250 uses an innovative gear honing wheel with external teeth.



Sicmat's Grono 250 gear honing machine is based entirely on CNC technology from NUM.

then has to be corrected by grinding or honing. Sicmat therefore set out to develop a high power honing machine that would help gear manufacturers accelerate production throughput by reducing the number of process stages.

Until now, gear honing automation has used highly specialist machine tools, comprising circular ring type assemblies with teeth cut in their internal face. These tools are expensive and time-consuming to set up. Sicmat believed that by using a honing wheel with external teeth, the accuracy of the process could be improved to such an extent that it could replace gear shaving in many applications, with the added advantages of lower tooling costs and much simpler set up. Initial research conducted in collaboration with the faculty of engineering at Turin Polytechnic University proved the practicality of the proposed new method.

A key requirement of honing automation is that it must have extremely high mechanical rigidity to ensure accurate and repeatable results. Sicmat therefore chose to base its new honing machine on the proven mechanical platform of its RASO TP 250 gear shaving machine. Developed over many years, this platform has exceptional stiffness and resistance to vibration—its bedplate is created from electro-welded steel filled with anti-vibration bonding, and the head, frame and tailstock are manufactured from cast iron. The platform's physical layout provides excellent accessibility for operation and maintenance, and its vertical workpiece positioning simplifies integration with other production line automation.

The Grono 250 has eight motion axes, plus another three on an associated robotic loader, all controlled by a NUM Flexium CNC system. The motors of all 11 axes are driven by high power density NUMDrive C servo drives, and the overall system is equipped with two NUM MDLL 3050 regulated power supplies. Each power supply is rated at 50 kW continuous and uses regenerative braking to maximize efficiency. The main machining axes are operated by direct-drive motors, while the honing wheel and workpiece axes are driven by powerful high torque motors, which are synchronized and controlled by application-specific software developed by NUM.

According to Marco Battistotti, director of NUM's Italian facility, the company's ability to develop custom software was a major factor in Sicmat's choice of CNC systems provider. "For this application, Sicmat needed specialist control software to provide extremely tight synchronization of the machine's honing axes. They also wanted to partner with a CNC company that was familiar with highly integrated machine architectures and prepared to handle custom engineering in parallel with their own development efforts, which are some of NUM's key strengths. The success of our collaboration was apparent immediately the first machine tests were run; the finished gears were of exceptionally high quality."

Every stage of the honing process on the Grono 250 machine is automated for efficiency. In normal use, the case hardened workpiece is removed from the production line conveyor by a robotic handler/clamp unit, which identifies the type



of gear by checking its outside diameter before transferring it to an integral pre-process measurement station. Here, the workpiece is synchronized with a secondary gear, then driven into mesh and rotated through a complete revolution; during this time, the displacement between the two axes is measured continuously to ascertain how much stock material needs to be removed from the workpiece, and this data is fed to the Flexium CNC system.

After measurement, a further robotic handler transfers the workpiece to the honing stage, where it is initially indexed before being run up to speed and synchronized with the abrasive toothed honing wheel. The honing wheel is then driven progressively into mesh with the



All machine axes are driven by NUMDrive C servos, controlled by a NUM Flexium CNC system.

workpiece. The two axes operate in a unique master-slave configuration that has zero delay of the slave axis, which required NUM to create a second master for the workpiece motor. Controlling the speeds of both these axes very precisely, and fractionally varying one relative to the other, facilitates fine adjustment of the honing process. Current-generation Grono 250 machines are capable of spindle speeds of 7,000 rpm, and Sicmat is already developing a machine with spindle speeds of 10,000 rpm to provide even tighter process control. As soon as the honing process is complete, the workpiece is disengaged from the honing

wheel, spun to remove coolant and then transferred back to the production line by the robotic handler.

Sicmat will be present at this year's IMTS in Chicago in Star SU's booth (N-6924) where engineers will be pleased to discuss the unique cost-saving advantages of the Grono 250 gear honing machine. NUM will also have a large booth (E-5135) at IMTS 2012, where the company will be highlighting its expertise in developing custom CNC software for OEMs and machine builders.

**For more information:**

NUM Corporation  
603 East Diehl Road, Suite 115  
Naperville, IL 60563  
P: (630) 505-7722  
[www.num-usa.com](http://www.num-usa.com)

Sicmat  
Via Torino, 35  
10044 Pianezza (TO), Turin, Italy  
P: +(39) 011 9667348  
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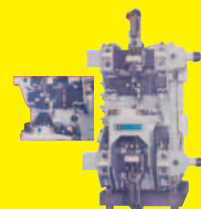
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### Two-Axis Servo/Rate Rotary System

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### Astro Guidance Test Platform

References the north star three axis (Ultradex) index system. System accuracy 0.3 arc second band, PC based control, IEEE-488 interface.



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# Ingersoll

## INTRODUCES T-MICRO SYSTEM

Ingersoll Cutting Tools introduces the T-Micro system specifically designed for the machining of very small internal diameters. The T-Micro system is a 2-piece design, consisting of a sleeve and replaceable carbide inserts. Applications include grooving, profiling, chamfering, face grooving/deep face grooving,

threading, and back turning starting at .024" (0.6 mm). The inserts feature coolant thru capabilities and are available in grade TT9030, a submicron substrate with PVD-TiAlN coating. Inside the new T-Micro sleeve design is a locating pin to ensure repeatability when indexing the inserts. This allows operators to



return to machining without resetting the tool. The locating pin also allows operators to replace inserts without removing the sleeve from the tool post. The T-Micro sleeve also features an angular clamping design to avoid interference when replacing the insert, allowing simplified tool change on Swiss-type and other multi-spindle lathes. Ingersoll offers this sleeve in many shank sizes: 0.500", 0.625", 0.750" and 1.00", as well as 12 mm, 14 mm, 16 mm, 20 mm, 22 mm and 25 mm.

### For more information:

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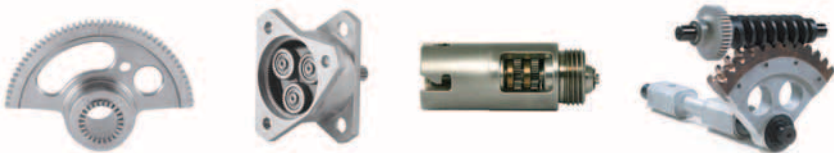




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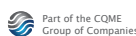
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# Renishaw

## OFFERS MACHINE TOOL INSPECTION PROBING

Renishaw's new RMI-Q multiple probe radio transmission system uses a single radio receiver for tool setting probe and spindle-mounted touch probe installations, offering fast integration and a cable-free machine environment. The system is easily integrated on a wide range of machining centers and CNC milling machines, offering users automated on-machine tool setting, tool breakage detection, part set-up and part verification capability. The full potential of Renishaw's new RMI-Q radio transmission interface is realized when as many as four separate radio transmis-



sion probes are operated on the same CNC machine, making it a suitable choice for fitment onto CNC machining centers or machines with rotary tables or twin pallets. A multitude of different multiple probing configurations is possible, typically comprising the new Renishaw RTS tool setter with Renishaw RMP60 inspection probe or other compatible spindle-mounted touch probes with radio transmission such as RMP40 or RMP600, selected to suit the user's specific application requirements. The new RMI-Q is used to activate either the spindle-mounted touch probe or table-mounted tool setting probe, and gives visual indication of the activated device. It features the tried and tested 2.4GHz (designed to be compliant with radio reg-

ulations worldwide) frequency hopping spread spectrum (FHSS) radio transmission, enabling uninterrupted operation in increasingly busy radio environments. The system is suitable for applications that have obscured line-of-sight to the probe, and its transmission range of up to 15 meters makes it particularly suitable on large machines. The RMI-Q has all the functionality of Renishaw's proven RMI, combined with additional features. RMI-Q allows easy acquisition using a simple macro to partner all required

probes to the interface in a single operation. Additionally, when RMI-Q is used in conjunction with an RTS and radio spindle probe it is possible for a simple automated calibration cycle to be run using the RTS stylus as the calibration artifact.

Renishaw's new RTS tool setting probe with radio transmission is a robust, compact and cable-free product which does not restrict table movement, and offers users broken tool detection combined with fast and accurate tool measure-

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ment. Its design is particularly suitable for machines with twin pallets or rotary tables, which historically have proven challenging for installations of hard-wired tool setters.

The RTS is designed to be compliant with radio regulations worldwide, using frequency hopping spread spectrum (FHSS) transmission on the 2.4 GHz frequency band. The RTS can measure both tool length and diameter of milling cutters, twist drills and end mills. Powered by two standard AA batteries and benefiting from significantly extended battery life, it is compatible with Renishaw's RMP60 and RMP600 spindle probes. The RTS can be used in conjunction with up to three other radio probes using the RMI-Q and is also compatible with the current product, the RMI.

**For more information:**

Renishaw, Inc.  
5277 Trillium Blvd.  
Hoffman Estates, IL 60192  
P: (847) 286-9953  
[www.renishaw.com](http://www.renishaw.com)

## Mahr INTRODUCES MARSURF XR1

With the introduction of the MarSurf XR1 surface measuring system, Mahr has bridged the gap between portable surface measuring devices and larger, full-featured, PC-based surface measurement and evaluation systems. The MarSurf XR1 combines the skidded and skidless drive units of Mahr's portable M-Series

instruments, with its *MarWin* evaluation software. The new XR1 provides an affordable entry into the world of modern, PC-based measurement and evaluation systems, including compliance with all international standards, diverse evaluation methods, extensive documentation, large storage capacity, data export and import, as well as networking and other benefits. "The gap between portable units and higher-end surface evaluation systems used to be quite large," said Pat Nugent, vice president of metrology for Mahr Federal, a member of the Mahr Group. "The XR1 sits squarely in that gap, offering users the benefits of both portability and fuller-featured evaluation in skidded and skidless measurements."

The MarSurf XR1 is suitable for use either in the measurement lab or on the shop floor, and provides over 80 parameters for R, P, W profiles according to current DIN, ISO, JIS, ASME and Motif standards. The system can utilize both the MarSurf RD 18 drive unit with skidded probe and the MarSurf SD 26 drive unit with skidless probe, and virtually any number of drive units can be connected to the evaluation unit via Bluetooth or cable. Measuring units can be used alone in different orientations, in combination with various accessories, or mounted on measuring stands. Measurements can be initiated either by touch screen on a PC or manually on the drive units.

The MarSurf XR1 comes standard with a basic version of Mahr's leading *MarWin* surface evaluation software, which





includes *Measuring Station View*; automatic user login; R, Rk, P, W, Motif, and D-profile and parameters; *Export ASCII*; *Profile Assistant* for USB; and *Measuring Assistant Level 1* for simple setup of measurement conditions. However, all the additional features of the XR 20 evaluation software are also available as option packages. These include: an *Advanced Evaluation* package with interactive zoom; virtual rulers and PDF file export; a *Multi-Measure* option package which expands the *Measuring Assistant* to Levels 2 and 3, as well as providing additional statistics and administration functions; an *Advanced Reporting* option with *PageDesigner* to create template forms and provide tolerance monitoring and display; a *Script Program Integration* option; *Digital I/O*, *QS-STAT*, and *Profile Processing Options*; and many more.

With the RD 18 skidded probe on the XR 1, cut-off lengths between 0.08 mm (.003") and 2.5 mm (.100") can be selected by the user or automatically determined based on the actual surface profile being measured. The ergonomically designed drive unit can take measurements in any position, and the prismatic shaped bottom can even act as a Vee block for positioning small parts. Threaded sockets in the undercarriage allow the attachment of accessories, and rechargeable batteries provide capacity for approximately 1,000 measurements before recharging.

Benefits of the MarSurf SD 26 Skidless drive unit on the XR1 include a proprietary motorized probe height adjustment feature that quickly and automatically zeros the probe in seconds and can cut measurement time in half, and a magnetic, breakaway probe mounting system which protects sensitive probes from accidental damage and facilitates fast probe changes. The MarSurf XR 1 is available with a wide range of probes, options, and accessories to allow the most flexible configuration for your applications.

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## Herring RELEASES BOOK ON VACUUM TECHNOLOGY

*Vacuum Heat Treatment*, written by Dan Herring, the "Heat Treat Doctor," is a new book focused on principles, practices and applications providing the heat-treating industry a comprehensive resource on the subject of vacuum technology, which is the fastest growing segment of the heat treat industry today. This book provides the reader with practical advice, a diverse set of application examples and a wide range of technical and engineering infor-

mation necessary to make informed decisions about how to heat treat and what equipment features are necessary to do the job. What makes this book unique is that it is written in such a way that engineers, metallurgists, heat treat operators, supervisors, managers, quality, industrial and manufacturing engineers and just about anyone interested in thermal processing or manufacturing can become skilled in the art and science of vacuum heat treatment. The book is scheduled for release this month, and preorder discounts are available using the link below. *Gear Technology* will be presenting material from the book in future issues. To

From complex micro-machining to cutting exotic, difficult-to-machine materials and creating new technology, Seco partners closely with manufacturers to understand the challenges you face and develop innovative solutions to meet your needs – we call this Secovation. At IMTS 2012, bring your challenges to us in Booth W-1564 to experience the solutions that will redefine your operations.



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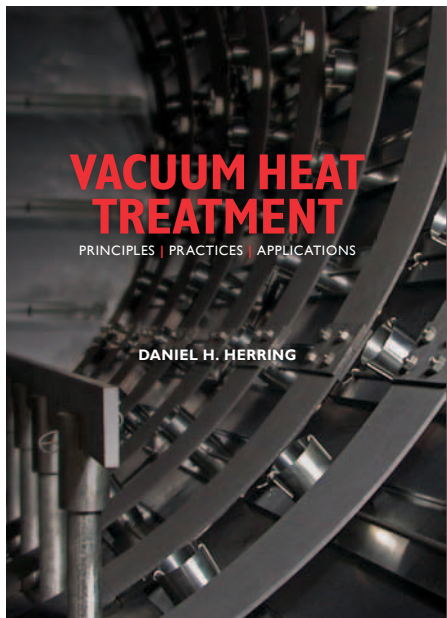
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## Forkardt OFFERS NEW WORKHOLDING AND CHUCK TECHNOLOGY

Forkardt has unveiled the latest workholding and chuck technology with the newest version of the firm's original UBL (universal ball lock) concept chuck. Meeting today's productivity, quality and ergonomic demands, the N.A. Woodworth ABL features a "quick-lock" jaw mounting system along with a weight-reducing, non-metallic composite core that provides high strength with the advantages of low mass operation. Together, the weight reduction and Q-C jaw system deliver secure, accurate workholding performance. These new, lightweight and quick jaw change chucks are available as three jaw, self-centering, or compensating systems and in sizes ranging from 160 mm to 460 mm (6" to 18") diameters. A variety of machine mounting styles, plates and adapters are also offered to match virtually all major machine structures and designs.

The quick-change jaw design allows changeovers to be accomplished in under 60 seconds, ideal for low-volume, part-to-part runs and the frequent changeover requirements of job shop environments. The "quick-lock", no-loose-screw style mount eliminates the need for master jaw sets, helping to minimize investment costs, tooling inventories and weight,



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yet is configured to provide high levels of precision, set-up ease, and excellent repeatability.

Second, the low-weight composite core construction — establishing an approximate 40% weight reduction when compared to like capacity, conventional chucks — provides benefits in five distinct areas, including reduced power consumption for lower utility costs and “green” operations. Because of the chuck’s diminished mass, spindle life will typically improve as machine components are exposed to minimized wear and tear — also resulting in reduced costs for maintenance, repairs and replacement parts.

This new concept in workholding design offers a unique benefit to the end user. The reduction in mass allows the operator to ramp up to speed much more quickly than with conventional pull down chucks. This same benefit also holds true when ramping down after cutting is complete. These two benefits provide true savings in production environments.

The new chuck permits operation on lower horsepower machines, thus expanding the working capacity and range of the machines, yet keeping capital investment and energy costs to lower budgeted levels.

The N.A. Woodworth ABL composite-core body also provides a damping effect while machining. The core absorbs vibration during turning, which results in better part finishes. Depending on the part tolerances, this benefit may eliminate unnecessary grinding.

The quick-change jaw mounting design, with fewer parts, also contributes to lower weights and the low mass reduces centrifugal forces to help prevent jaw slippage, machining errors and increased spindle speeds. The new chucks are completely sealed to prevent internal contamination while an innovative design provides improved chip evacuation, allowing for more reliable and accurate workpiece positioning.

**For more information:**

The Forkardt Group  
ITW Workholding  
2155 Traversefield Dr.  
Traverse City, MI. 49686  
P: (800) 544-3823  
sales@forkardt.us  
www.forkardt.us

# Okuma

## HIGHLIGHTS CNC LATHE AT IMTS

Okuma America Corporation recently announced that the new LT-3000EX, a high-powered CNC lathe, will be shown for the first time in the United States at IMTS 2012 (Okuma Booth S-8500). The LT-3000EX is now the largest in Okuma’s LT-EX series of horizontal lathe machines. This fully-loaded CNC lathe

is available in either two- or three-turret versions, with or without Y-axis, to provide optimum process balance, production throughput and integrated operations. The LT-3000EX delivers precision turning in any direction, and is well suited for high production environments such as the automotive industry. The LT-3000EX is available with 16 turret stations to allow for redundant tooling in order to best utilize back-up tooling for lights-out manufacturing or high production runs. It offers very high feature utili-

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zation and the greatest amount of primary and secondary machining possible in one compact platform. The machine can be specified in a large number of different configurations to maximize benefits for specific production environments.

- Key Specifications for the LT-3000EX:
- Maximum Turning Diameter: Ø 13.77 in (350 mm)
  - Spindle ID: 3.15 in (Standard Bore) or 3.58 in (Big Bore) [80 mm or 91 mm]
  - Spindle Nose Type: A2-6 (A2-8 optional)
  - Chuck Class: 8-inch
  - Speed Range 45~5,000 min<sup>-1</sup> (45~4,200 min<sup>-1</sup> optional)

- Standard Power: VAC 22/15 kW (30/20 hp) [30/22 kW (40/30 hp) optional]
- Twin Opposed Spindles: A-B operation simultaneous, 4-axis simultaneous turning on either spindle
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# IMTS 2012

## Product Preview



### LIEBHERR GEAR TECHNOLOGY, INC.

Booth N-6930

The LFG1000 CNC Gear Profile Grinding Machine, and the LCS 500 CNC Gear Generating and Profile Grinding Machine, which are ready to use the latest and proven grinding technology in the marketplace, will be featured at IMTS 2012. Both gear grinding machine types are good for machine shops which have to produce a single part or higher batch sizes. Liebherr offers several technologies including gear hobbing, profile milling, gear shaping, generating gear grinding and profile gear grinding.

Recently, Liebherr's engineering and sales team weighed in on the trends that are driving innovation in gear manufacturing today and the technologies that will be available at IMTS.

"On profile and generating grinding, most gear manufacturers need the possibility to create gear flanks with special topological modifications on a high quality level. With these modifications, it is possible to increase the load-carrying capacity of gears, and also to reduce the gear

noise behavior," says Dr.-Ing. Andreas Mehr, technology engineer, Liebherr-Verzahntechnik GmbH in Kempten, Germany. "We see this trend on all gears, from the small module gears used in automotive, to the larger ones used in trucks and tractors, and even up to the coarse-pitch applications for wind energy and heavy industrial transmissions. If you can grind these topological gears in addition with a higher efficiency—for example, with dressable CBN tools, or generating-grinding of large module (up to module 14 mm with our LCS 700, 1200), instead of profile grinding—then these customers will have a big productivity advantage against their competition."

"The need for chamfering and deburring of gears in the green manufacturing process chain has led to innovative integrated chamfering and deburring systems within gear hobbing machines," says Scott Yoders, vice president sales at Liebherr Gear Technology, Inc. "In this regard, years ago Liebherr successfully introduced ChamferCut Technology

(together with the cutting tool company LMT-Fette) to industrial mass and medium-size production applications. Recently these integrated chamfering systems within the LC gear hobbing machines have been expanded upon by Liebherr to include separate 'parallel processing' stations such as Rausch-Gratomat, or roll-press deburring. Within the



same machine, and with the parallel processing, the total cycle time for both hobbing and chamfering is not elongated. For coarse-pitch gear applications, carbide indexable inserted tools (milling cutters and hobs) have definitely gained more and more importance in North America. Although gear manufacturers' initial investment in hob cutting tools is higher, the productivity due to larger batch sizes is much better, so it pays off. Therefore, for the production of coarse-pitch gears, Liebherr hobbing machines equipped for carbide-insert tooling have become more and more the state-of-the-art."

Adds Dr.-Ing. Oliver Winkel, technology engineer, Liebherr-Verzahn-technik GmbH, "At Liebherr there has been focus on the reduction of machine idle times, which fits to the trend of decreased cutting times coming from improved cutting tool materials, and technology parameters (speeds, feeds). This means, faster loading/unloading of workpieces, easier setup or changeovers, and measuring within the machine. Lower idle times by faster load and unload, as well as improved control programs, immediately reduces the cost per piece for our Liebherr customers."

"With regards to gear grinding, the







use of dressable CBN, or other powerful abrasives, will have a very important impact, because the grinding time (which influences mainly the workpiece costs per part) is drastically reduced,” Mehr says. “Where in the past you may have needed three machines to produce a specific quantity of gears per day, you now would need only one.”

**For more information:**

Liebherr Gear Technology, Inc.  
1465 Woodland Drive  
Saline, MI 48176  
P: (734) 429-7225  
[www.liebherr.com](http://www.liebherr.com)

**KLINGELNBERG  
GMBH**

Booth N-6930

Klingelberg presents its latest skiving innovations at IMTS 2012. This tool system can be used on bevel gear milling machines and allows



for a productive, stable and precise production process, particularly for internal gears. Despite high productivity and system-inherent accuracy, the breakthrough of skiving has been denied due to the tool problem. The chip formation process in skiving is very complex whereby large nega-

tive rake angles and only very small clearance angles arise during the process. The current tools, mostly cylindrical or conical solid carbide cutting wheels, have no degree of freedom for the necessary optimization. In addition to high machining forces, negative cutting angles also consistently lead to excessive wear of the tools, meaning that the tool costs per component largely surpass the proportional machine costs.

Klingelberg’s newly developed

software shows the exact chipping conditions and therefore allows for a targeted optimization of the cutting geometry and the production movement. The new stick blade tool system uses carbide technology, which has long been used for bevel gears. “Skiving itself is in fact an ancient concept. The key innovation hereby lies in the use of stick blades and the resulting design possibilities for the cutting edge—a breakthrough in cutting technology,” says Dr. Hartmuth

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See us in Booth N-6918

Müller, CTO of Klingelberg.

The stick blade has the distinct advantage of offering optimal cutting geometry through grinding. This is a necessary condition for the optimization of the chip formation process and therefore forms the basis for the breakthrough of skiving. The entire process is highly energy-efficient, productive and flexible. In addition to the free design of the tool, tooth flank modifications can also be applied by superimposing additional movements during the skiving process. These advantages in comparison to gear hobbing, gear shaping or broaching are of particular importance for the production of internal gears. A simple comparison of shaping and skiving productivity shows that skiving is up to ten times quicker and offers a significantly longer tool life. Although skiving is a machining process using a defined cutting edge, the surface qualities achieved are outstanding. Due to the

very high frequency with which the cutting edges move across the tooth flanks to be produced, a completely different surface texture is achieved than, for example, that of gear hobbing or shaping. In the image, the movements of two successive cutters in the tooth space are displayed as blue tracks. The distance of these tracks is determined by the axial feed rate with which the tool is moved along the face width of the gear to be produced. The cutting frequency is up to ten times higher than that of gear hobbing. As a result, a finer surface texture is achieved without the hollows created by gear hobbing or the grooves created by shaping and caused by tool wear. The incorporation of all steps along the process chain to form a continuous data network, guarantees stable and secure manufacturing processes. For Klingelberg this is a trusted and globally approved approach within the scope of the closed-loop concept.

In order that the user is able to benefit from the same process security for skiving as that for bevel gearing, Klingelberg has developed the closed loop for skiving which also incorporates tool preparation operations. Skiving can be executed on the Oerlikon C29 and C50 bevel gear milling machines. These machines ensure a highly precise coupling of all movements which are necessary for skiving. The highly dynamic process also requires a rigid machine design. The vertical arrangement of the tool and workpiece spindle offers particularly favorable conditions for chip removal. The C29 and C50 machine series meets all conditions required for skiving.

**For more information:**

Klingelberg GmbH  
1465 Woodland Drive  
Saline, MI 48176  
P: (734) 429-7225  
[www.klingelberg.com](http://www.klingelberg.com)

## SANDVIK COROMANT

Booth W-1500

The Sandvik Coromant Smart Hub at IMTS 2012 will focus on helping attendees discover new ways to boost their business through knowledge, tooling solutions and services. With demands from the growing manufacturing industry being high, the Sandvik Coromant Smart Hub will bring visitors solutions in hole-making, gear milling, automotive, energy and aerospace.

High-tech, dedicated areas in the "must see" hub will highlight application specific tips and techniques needed to optimize programming strategies for successful manufacturing. A visit to the Smart Hub will provide the opportunity to preview some of the new developments in high-performance drilling products offering tremendous opportunities for customers to explore productive methods in various operations.

On display, the new Sandvik Coromant CoroDrill 860 solid carbide drill provides fast, economical, problem-free drilling, optimized for steel and most recently for high productivity in all types of aluminum. In addition, visitors can preview a multi-application, high-performance drill that can be used across a wide range of materials. For the exchangeable-tip drills, the CoroDrill 870 will be extended with an optimized grade and geometry for cast iron materials.

Gear milling is an area that is developing fast, and the CoroMill 176 indexable insert cutter can help attendees overcome challenges in productivity, cost and accuracy. Sandvik Coromant also invites its visitors to learn more



about its unique and highly competitive machining solutions intended to provide efficient production in the automotive, energy and aerospace sectors.

The company's CoroMill Plura family sees an extension for aluminum, optimized for machining in thermoplastics, which is excellent for die and mold applications. The CoroDrill 861, on the other hand, is suitable for applications that need a stable tool for the deepest holes and is a high-performance choice for a typical cast iron engine block.

With the introduction of the CoroMill 600 at IMTS, Sandvik Coromant will now offer a full program of blade machining milling tools for the power generation industry. For demanding applications in the oil and gas and aerospace industries, a new counter bore, to be launched in October, offers high process security.



# ATLAS

Ipsen's ATLAS® integral quench furnaces are highly engineered, sophisticated machines that are easy to operate and maintain, all while being extremely cost effective. ATLAS delivers top quality uniformity through cutting-edge technology and design:

- Intelligent controls, Carb-o-Prof®, provide you with your very own electronic metallurgist
- SuperQuench with adjustable oil speed and four 40HP agitators
- Muffle system for uniform temperature control
- Safety – all ATLAS furnaces are water-free for maximum safety
- 30% less gas consumption
- Recon® burners – single ended recuperated tubes (SERT)

## HybridCarb®

The unique HybridCarb® gassing system from Ipsen is an ultra-efficient gassing system designed to replace endothermic generators and other gassing systems. Its core strength is precision gas control. Instead of burning excess gas off, the process gas is reconditioned and reused, increasing efficiency up to 90%.

Other benefits of HybridCarb include:

- Quick and easy hookup
- Increased carburizing efficiency
- Reduces CO<sub>2</sub> emissions by 90%
- Significantly less expensive to operate than endogenerators
- Consumes significantly less gas
- Environmentally friendly and cost efficient
- Lowers heat output creating a more comfortable work environment
- Powers up and down at anytime, quickly and easily



For more information please visit [www.IpsenUSA.com](http://www.IpsenUSA.com)



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ery Express” seminars will emphasize application techniques that can be used in various operations. Topics will range from effective chip thinning to pitfalls in reconditioning.

**For more information:**

Sandvik Coromant  
1702 Nevins Road  
Fair Lawn, NJ 07410  
P: (800) SANDVIK  
[www.sandvik.coromant.com/us](http://www.sandvik.coromant.com/us)

## HEXAGON METROLOGY INC.

Booth E-5202

Hexagon Metrology Inc. will exhibit a full complement of metrology solutions with a spotlight on the new Cognitens WLS400A for automated measurement applications and *PC-DMIS 2012* inspection software. The company will also demonstrate recently released products: Romer portable arms, Optiv Vision 321, Sheffield and Brown & Sharpe 4.5.4 SF CMMs, and *PC-DMIS* software.

Hexagon will also showcase an official racecar from Hendrick Motorsports, winner of a record 10 NASCAR Sprint Cup Series championships. Hendrick Motorsports is a long-time user of Hexagon Metrology products for inspection and assembly of auto body, chassis and engine components for both pre-race adjustment and post-race evaluation.

At IMTS, Hexagon Metrology will debut the Cognitens WLS400A, designed for automated inspection applications. The 3-D optical measurement solution can transform a robot into a high-accuracy metrology device. Suitable for the motor vehicle or aerospace industries, the white light



“As a market leader in the industry, Sandvik Coromant always strives to stay at the forefront of innovation by working directly with our customers to offer them the solutions they need to meet their demands,” said Jamie Price, president, Sandvik Coromant U.S. “We are looking forward to interacting with our customers and being a part of this great event.”

To help visitors take full advantage of tooling solutions and technologies, Sandvik Coromant will offer short technical seminars, presented by yellow coat experts. The “Discov-



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ments and new enhancements have been added to *PC-DMIS 2012*, which is used to create, automate and customize inspection routines, and to build lean manufacturing operations. The extensive product line includes *PC-DMIS CMM*, *PC-DMIS NC*, *PC-DMIS Planner*, *PC-DMIS Portable*, *PC-DMIS Vision*, *PC-DMIS Reshaper*, *PC-DMIS Gear*, *PC-DMIS Blade*, *PC-DMIS Retrofits*, and *DataPage*.

**For more information:**  
Hexagon Metrology  
250 Circuit Drive  
North Kingstown, RI 02852  
P: (800) 274-9433  
[www.hexagonmetrology.us](http://www.hexagonmetrology.us)

based system is used to accurately measure large components, analyze early root causes of potential assembly issues, and lower scrap costs during assembly ramp-up. The manual version of the system, the Cognitens WLS400M can also be utilized for rapid prototype part development, and used to certify holding fixtures and assembly tools.

The WLS400A uses digital stereo vision technology to generate highly accurate 3-D data in vibration-prone shop floor environments. Due to the system's ultra-fast data acquisition rate (less than 10 milliseconds), any vibration in frequencies up to hundreds of Hz do not affect the results. The device's performance is not impaired by variable lighting or temperature changes, making it a robust troubleshooting tool for complex engineering issues during product development or for automated measurement tasks. The 3-D measurement solution can also be used to standardize quality criteria across global production facilities and with suppliers

Hexagon will also feature *PC-DMIS 2012*, the company's popular CMM software developed for the collection, evaluation, management and presentation of manufacturing data. The software is standard on all Hexagon Metrology measurement devices, and also available on non-Hexagon equipment. Incremental improve-

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## WALTER USA, LLC

Booth W-1700

Walter USA, LLC, will feature Tiger-tec Silver for turning; Walter Titex X-treme Inox solid carbide drills; Walter Prototyp Proto-max Inox solid carbide end mills; the new ValCool VPLFC low-foaming coolant; and a new generation of Walter Valenite indexable milling cutters. Tiger-tec Silver delivers superior resistance to crater and flank wear, plastic deformation, considerably reduces machining times and ensures higher process reliability. The combination of three new insert grades and four new geometries developed in parallel increases tool life and boosts productivity of steel turning applications. The new grade designated WPP10S offers the highest temperature resistance and hardness. It is suitable for processes ranging from continuous cutting to minor interrupted cuts at very high cutting speeds. WPP20S, the medium-grade, is suitable for use as a universal cutting material for processes ranging from roughing to finishing. WPP30S, the toughest of the three, brings maximum reliability to difficult applications such as interrupted cuts and unstable



conditions. In addition to the three grades, Tiger-tec Silver for turning includes four new geometries. For facing and light cuts, the FP5 provides reliable chip control during turning operations from 0.008-in. depth of cut. The MP3 geometry is suitable for medium machining. The versatile MP5 geometry was specifically designed for general machining and the RP5 geometry is designed for roughing. Walter Titex X-treme Inox solid carbide drills for stainless steel provide for a new flute profile, point geometry and TTP coating for reduced cutting force and longer tool life. Walter Prototyp Proto-max Inox solid carbide end mills for stainless steel achieve material removal rates up to 50 percent greater than stan-

dard solid carbide end mills. These include an optimized geometry that provides enhanced stability for the cutting edges, and a special surface treatment on the shank for a firm grip. ValCool VPLFC is a heavy-duty, non-chlorinated, semi-synthetic low foaming cutting fluid which helps reject tramp oils is very clean and stable and is ideal for high pressure (1,000 psi +) applications. A new line of indexable milling cutters to enhance productivity and speeds and feeds will also be unveiled during IMTS.

### For more information:

Walter USA, LLC  
N22 W23855 Ridgeview Pkwy West  
Waukesha, WI 53188  
P: (800) 945-5554  
[www.walter-tools.com/us](http://www.walter-tools.com/us)

## SAINT-GOBAIN ABRASIVES

Booth N-7051

Saint-Gobain Abrasives, the world's largest abrasives manufacturer, has recently introduced Norton Paradigm Diamond and CBN Wheels which are positioned in the "Best" tier of Norton grinding products. Paradigm wheels feature a new proprietary, patent-pending bond delivering high grinding performance on carbide and high-speed steel round tool fluting, resulting in exceptionally fast cycle times and lower cost per parts. "The new patent pending bond on Paradigm Diamond and CBN wheels enables high performance one-pass flute grinding for highly efficient round tool manufacturing operations," said Matt Simmers, product manager at Norton. For maximum

productivity, new Norton Paradigm wheels are online and offline truable. Wheels are wear/load resistant for superior grinding on 6 to 12 percent cobalt, and offer better control over core growth. A high grain retention and uniform structure provides a high G-ratio (ratio of material removal rate versus wheel wear) up to 2.5x longer wheel life and a 30 percent higher material removal rate than other superabrasive wheels. Paradigm Diamond and CBN Wheels also offer low specific cutting energy, which enables faster grinding with a lower power draw and less burn. All Paradigm Diamond and CBN Wheels

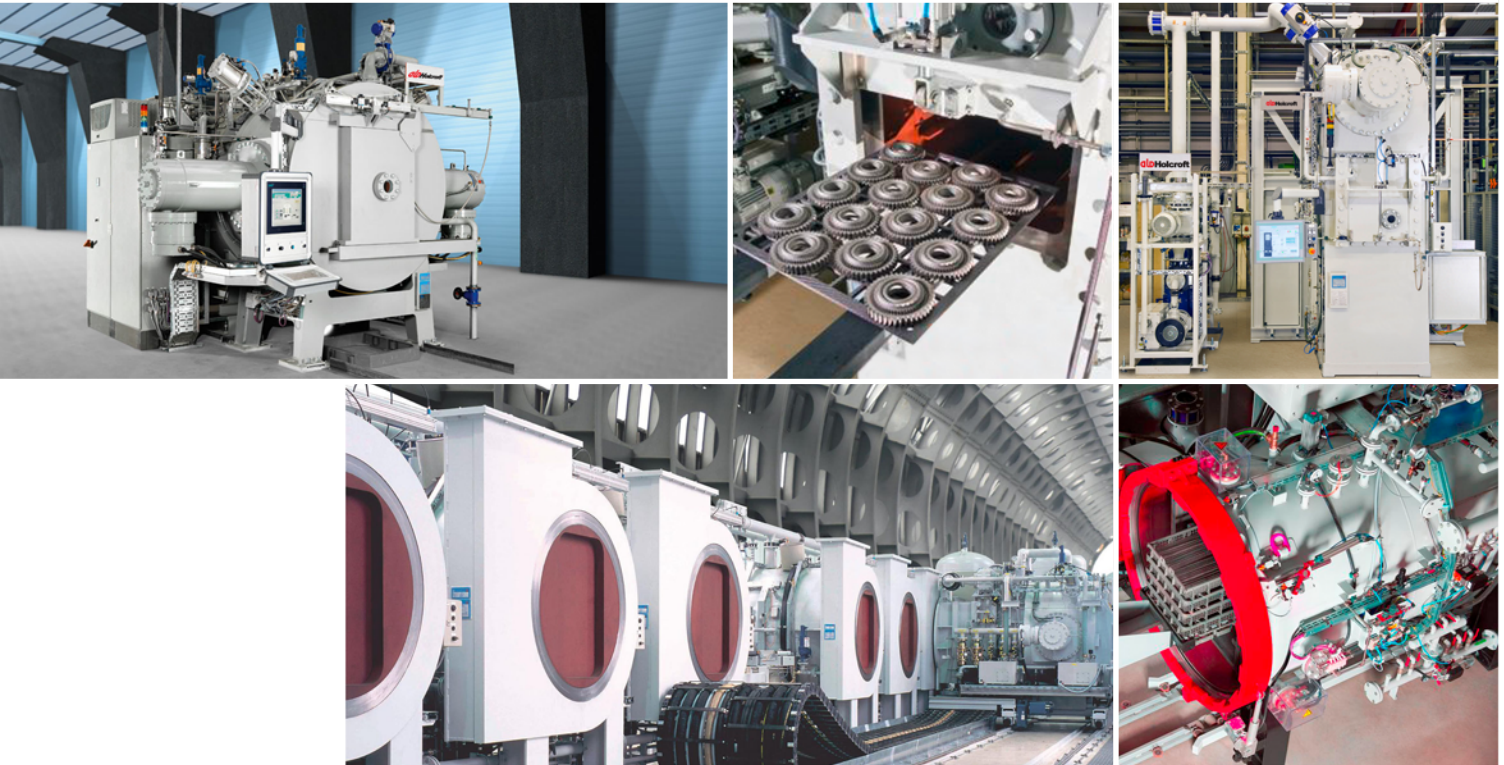
are custom-manufactured to precisely meet end-user requirements. Wheels are available for Anca, Makino, Rollomatic, Star, Walter and other leading grinding systems. Diamond wheels are available for tungsten carbide and CBN wheels are offered for





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high-speed steel applications.

Additionally, Norton Abrasives will be featuring several Machine to Grind (MTG) solutions. For example, with Norton's MTG analysis, a gear manufacturer eliminated rough cutting the gears through the use of formed cutters, broaching or hobbing. They ground from solid to eliminate the need for a cutting/milling machine and all the complementary tooling and equipment required to start and maintain the rough cutting

operation. Norton provided wheel specifications to create the flexibility to combine grinding in the soft state from solid to hard finishing with only one grinder.

Opportunities for the MTG solutions include small to medium job shops where there are two similar machining operations followed by grinding or where an antiquated cutting machine has caused the need for a rough machining process followed by a rough grind before the heat treat

and finally a finish grind. Other typical industries for MTG include aerospace, land-based heavy, off-road truck gears (soft machine, hardened and finish grind). To learn much more about a case study including a key OEM who greatly benefited by applying a Norton MTG solution to grind large spiral bevel and pinion gear sets from a solid, visit the booth N-7051 at IMTS.

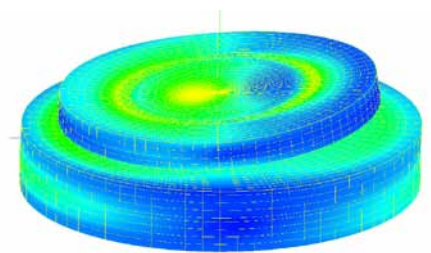
**For more information:**

Saint-Gobain Abrasives  
One New Bond Street  
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Worcester, MA 01615-0008  
P: (508) 795-5000  
[www.sgabrasives.com](http://www.sgabrasives.com)

**DONTYNE  
SYSTEMS**

Booth N-6791

Dontyne Systems has developed a Gearbox Model to simulate deflection of a fully coupled system of gear, shaft and bearing components including the housing. The tool can utilize FE data from 3rd party software. Deflection data can be passed directly to the tooth contact analysis module *Gates* to provide a substantial improvement for the existing customer base. Detailed component design can be called directly within the model. Further development will see planetary systems and NVH analysis possible. Dontyne has integrated MESYS AG calculations for shafts and



bearings with a significant increase in the capability of the *Gear Production Suite*. *MESYS* bearing calculation considers the load distribution in the bearing and therefore can take into account operating clearance, tilting angle or moment load. The shaft calculation uses the resulting non-linear bearing stiffness and is therefore

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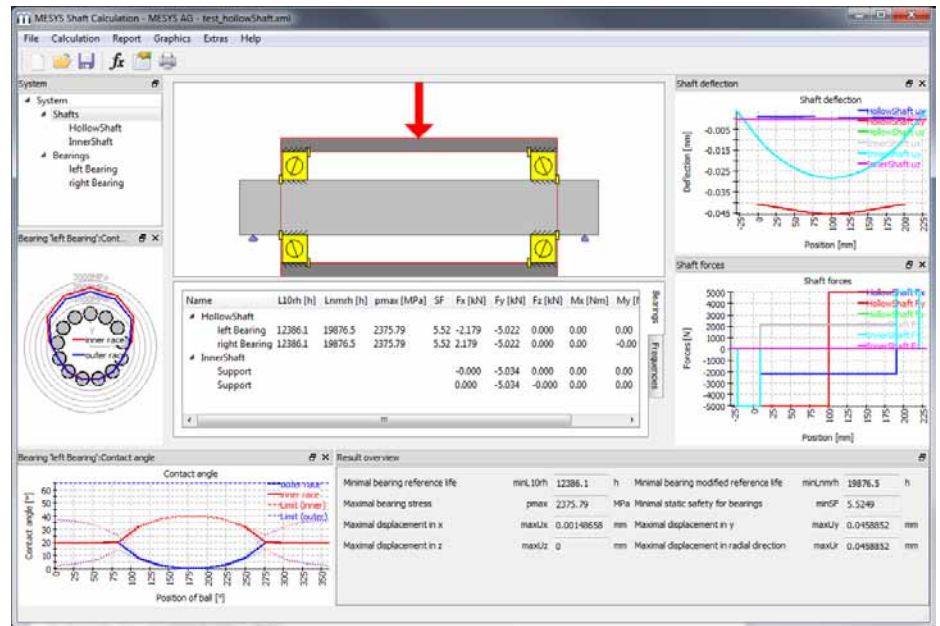


suiting for statically indeterminate systems.

“We are very excited about the relationship developing with MESYS,” says Mike Fish of Dontyne. “The software produced by MESYS is of high quality and fits precisely with our strategy. As with our own approach to gears, the new software calculates according to standards but also give access to higher level of detailed analysis required for high performance applications. We are also well aware of the pedigree of MESYS to be sure of providing the fast and flexible support for our customers.”

“Considering housing stiffness, bearing clearance and stiffness and automatic calculation of shaft deflection will increase the accuracy of inputs for TCA,” says Markus Raabe of MESYS. “Like the integration of MESYS shaft and bearing calculation in Dontyne software, parts of Dontyne gear calculations and TCA should be accessible from MESYS software in the future.”

Renishaw continually develops its MODUS metrology software appli-



cation to meet the demanding requirements of customers in a global market. A joint development with Dontyne Systems has resulted in the release of MODUS Gear and MODUS Spline software. The gear metrology expertise from Dontyne and the applications experience of Renishaw was an ideal combination to pro-

duce software that offers a high level of functionality and exploits the benefits of Renishaw’s coordinate measuring machine (CMM) scanning systems.

Eaton and Dontyne Systems have completed the improvement and integration of design and manufacturing software to significantly reduce

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product development time in the production of bevel gear systems. The dramatic improvements have demonstrated Dontyne's ability to deliver complex development in a relatively short time frame. Tom Riley of Eaton Corporation said of the collaboration, "Dontyne's software brought us a huge improvement in productivity: reducing hours of work to seconds. The visual representations make the software very intuitive to use and understand, and the results are quite accurate. The endeavor was so successful that more collaboration is inevitable."

"We were delighted to work with Eaton on the recent project, and very happy to hear about the significant improvements in production enabled by the development," Fish said. "This has once again proven Donyne can deliver customer specific requirement to utilize a large internal knowledge base of design and machining procedure, which can be developed as a stand-alone program or integrated to our off-the-shelf design and analysis tools in the *Gear Production Suite* if required."

This and other developments at Donyne will be discussed during IMTS in Chicago.

**For more information:**

Dontyne Systems  
Rotterdam House  
116 Quayside  
Newcastle Upon Tyne  
England  
P: +(44) 191 206 4021  
[www.dontynesystems.com](http://www.dontynesystems.com)

**SCHUNK**

Booth W-2000

"Success in Manufacturing" will be Schunk's theme for IMTS 2012. On a 4,000 sq ft booth, visitors will experience the "Schunk Blueboard," which presents straightforward stories of how manufacturers stay competitive. Each story compares a successful company with a non successful company and asks the question, "What leads to success in manufacturing?" The "Schunk Blueboard" will give answers to this question. Each Blueboard station will be an interactive experience for the visitor, highlighting a different problem such as reducing part cost, increasing flexibility, and improving machine idle

times. Products highlighted include the electrically driven small parts gripper EGP. Compared with other electrically driven small parts grippers on the market, it scores points with respect to its high speed and simultaneous high gripping force. A powerful roller guide ensures high efficiency and makes the gripper highly dynamic, especially for demanding pick and place applications.



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Schunk will also highlight its premium gripper range with multi-tooth guidance. The guidance tasks in parallel and centric grippers are not carried out using the classical T-slot but with a multiple prismatic guidance arranged in parallel. Therefore forces and moments are distributed across multiple guiding areas. As a result, the guidance has a higher load capacity. The three-finger centric gripper PZN plus series has been extended with the new size 380 to cope with the constantly increasing performance requirements of the manufacturing industry. This series can be used to handle workpiece weights over 300 kg (660 lbs).

**For more information:**

Schunk  
211 Kitty Hawk Drive  
Morrisville, NC 27560  
P: (919) 572-2818  
[www.schunk.com](http://www.schunk.com)

**EMUGE CORP.**

Booth W-1536

Emuge Corp. will showcase their comprehensive line of clamping solutions at IMTS 2012. Emuge's workholding division specializes in providing highly accurate, almost maintenance-free customized solutions for applications from low volume job shops to high volume automotive production environments. "Our workholding group stays close to our customers to learn about their unique challenges and



production environments. Doing so helps us develop the best solutions for their applications," says David Jones, precision workholding manager at Emuge Corp. Highlights at IMTS 2012 include: Emuge's System SG used in many machining operations such as hobbing, shaping, and shaving for gear production, as well as milling and inspection. The System SG's large surface area contact with the workpiece provides a clamping solution which is very rigid, accurate and repeatable. The high preci-

sion System SP is used not only to clamp workpieces but also to clamp tools. By applying an axial force, the clamping sleeves move in the direction of the force and expand radially. This eliminates the clearance between clamping sleeve and body, and between clamping sleeve and workpiece. System SP achieves concentricity of  $\leq 0.002$  mm (corresponding to  $\leq 0.0001$  inch). For workpieces that have a short clamping base or for diameters with a very large tolerance, System SZ is a suitable choice.

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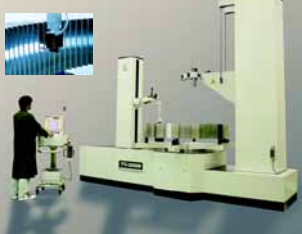
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By applying an axial force, a slitted collet is radially expanded by a cone. Simultaneously an axial movement occurs, clamping the workpiece. When the eccentricity between pitch circle and seating bore is very small, diaphragm clamping System SM is ideal. It allows clamping of the gear wheel at the pitch circle for machining the seating bore. The gear wheel is clamped in both axial and radial directions. System SH is the solu-

tion if there is not enough room for a mechanical clamping system and for clamping long, thin-walled workpieces or a number of similar workpieces. System SH is a closed system which uses hydraulic pressure to clamp the workpieces.

#### For more information:

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P: (800) 323-3013  
[www.emuge.com](http://www.emuge.com)

## HOMMEL-ETAMIC AMERICA CORP.

Booth E-5545

Jenoptik Industrial Metrology will demonstrate the new Hommel-Etamic F435 and F455 automatic form measuring system at IMTS 2012. The system completes fully automatic measurement of geometrical tolerances, surface roughness and straightness in a single setup. An advanced probe design permits roughness and waviness inspections along with form and position tolerance measurements via a simple adjustment on the rotary control, thus significantly enhancing productivity. Designed for workpieces of up to 40 kg weight and 430 mm in diameter, the systems can measure products such as gear shafts, injection parts, bearing rings, valves, connecting rods and pistons. Jenoptik offers specialized solutions to extend the application scope to include brake disc measurement as well. Individual configuration allows optimum measurement situations for specific tasks.

Available as a compact desktop version or a complete ergonomic measurement workstation, the systems include a frictionless air bearing rotary table that ensures the reproducibility of the smallest tolerances over long periods of time.

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by wobble. High precision guides equipped on both the R and Z axes and specially designed drive systems all combine to deliver superior precision and speed.

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#### For more information:

Hommel-Etamic America Corp.  
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Rochester Hills, MI 48309  
P: (248) 853-5888  
[www.hommel-etamic.com](http://www.hommel-etamic.com)





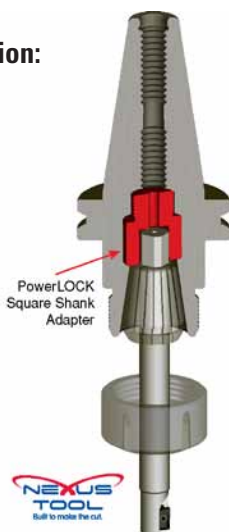
## NEXUS TOOL

Booth W-1732

Nexus Tool will introduce its patented ShrinkMILL System at IMTS this year. The ShrinkMILL uses shrink fit technology to make a perfect connection between the arbor and face mill for maximized performance. This is done by heating the face mill in the shrink fit machine, which expands the bore to receive the face mill arbor. The ShrinkMILL System eliminates any tolerance between the arbor and the face mill creating the shrink fit connection. Because the connection is shrink fit, runout and vibration are reduced, permitting increased feeds, extended insert life, and better surface finish. Nexus provides complimentary shrink fit services to its customers who do not own their own machine. According to Mike Raper, Nexus Tool national sales manager, "The ShrinkMILL System brings the greater rigidity and accuracy of shrink fit to milling applications for faster cutting and better surface finish. Also, scrap rates are reduced and insert life is improved." The ShrinkMILL System includes Nexus Tool's face mill arbors and face mills that are manufactured to precise tolerances required by the shrink fit process. Choose from a wide range of Nexus multi-coated inserts for all materials as well high-polished inserts optimized for aluminum. Additionally, Nexus will introduce its PowerLOC system at IMTS, a product that significantly improves T.I.R compared to standard end mill holders.

### For more information:

Nexus Tool  
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Our newest addition to the Delta Family of Companies is Delta Inspection. Inspired on the understanding that the industry needs expert abilities for contract gear inspection services, Delta Inspection has been introduced to meet your gear inspection and testing needs. Our abilities range from gear inspection up to 39 inches (1 meter) to prismatic inspection of machined components, roundness, laser guided concentricity analysis, surface testing, material testing, Nadcap certified magnetic particle inspection, nital etch and much more.

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Delta Research is a world class provider of CNC 3-Axis, 4-Axis and 5-Axis precision machining, jig grinding, cylindrical grinding, precision gears and complete assemblies for automotive, aerospace and industrial applications. From complete automotive prototype transmissions or components, to defense, to aerospace machining and assembly, you will be impressed by our capabilities and commitment to quality.



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# IMTS 2012

The following IMTS exhibitors are suppliers of products or services that may be of interest to gear manufacturers who visit the show. The Booth numbers include a letter indicating which building the booth is in (N=North, S=South, E=East, W=West).

## Alphabetical Listings

COMPANY	BOOTH
American Broach & Machine Company	N-7027
American Gear Tools	N-7027
American Wera Inc.	N-6260
Andantex USA Inc.	N-6035
Atlanta Drive Systems Inc.	N-6420
Banyan Global Technologies	N-6670
Bates Technologies	N-7451
Bourn & Koch Inc.	N-6924
Broach Masters/Universal Gear	N-7112
Broaching Machine Specialties Co.	N-7229
Carl Zeiss Industrial Metrology, LLC	E-5504, N-6918
DMG/Mori Seiki USA	S-8900
Dontyne Systems	N-6791
Dr. Kaiser	N-7240
Drake Manufacturing Services Co.	N-6918
DSM Functional Materials	N-6072
DTR Corp.	N-6658
Dura-Bar	W-1272
Eldec Induction USA	N-6663
EMAG LLC	N-6846
EMAG Maschinenfabrik GmbH	N-6918
Emuge Corp.	W-1536
Engis Corp.	N-7325
Erasteel Inc.	W-1381
Erwin Junker Machinery, Inc.	N-6840
Escofier SAS	N-6026
Euro-Tech Corp.	W-2453
Federal Broach and Machine Company	N-6924, N-7046
Felsomat USA, Inc.	N-7024
Frenco GmbH	W-2453
FROEMAG	N-7220
Fuji Machine America	S-9059
<i>Gear Technology</i>	N-7148
Gehring L P	N-6740
Gehring Technologies GmbH	N-6740
Gleason Corporation	N-7000
Gleason Cutting Tools Corporation	N-7000
Gleason Metrology Systems Corporation	N-7000
Gleason-Hurth Maschinen und Werkzeuge	N-7000
Gleason-Pfauter Maschinenfabrik GmbH	N-7000
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Guysong Corp.	N-7245
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Halifax Rack & Screw -North America	N-6789
Hamai Co.	N-7451
Hangsterfer's Laboratories	N-7526
Hassay Savage / Magafor	W-1592
Hexagon Metrology	N-7163, E-5202
Hofler Maschinenbau GmbH	N-6837
Index Corp.	S-8450
Ingersoll Cutting Tools	W-1822
J. Schneeberger Corp.	N-6936
Kapp GmbH	N-7036
KAPP Technologies	N-7036
Kennametal Inc.	W-1522
Kitagawa Northtech Inc.	W-2412
Klingelberg GmbH	N-6930
Koepfer America, LLC	N-6918
Leistriz Corporation	N-6746
Liebherr Gear Technology, Inc.	N-6930

## Alphabetical Listings

COMPANY	BOOTH
LMT USA Inc.	W-2464
Logansport Machine Company	W-1314
Luren Precision Co. Ltd.	N-7072
MAG IAS LLC	S-8519
Mahr Federal Inc.	E-5242
Marposs Corp.	E-5519
Mazak Corp.	S-8300
Mecanica Comercial Meco, S.L.	N-7124
Mijno Precision Gearing	N-7227
Mitsubishi Heavy Industries America - Machine Tool Division	N-7046
Mitts & Merrill L.P.	N-7220
Mitutoyo America Corp.	E-5214
Monnier + Zahner AG	N-6918
Mutschler Edge Technologies	W-1843
Nachi America Inc.	W-2279
Nagel Precision	N-7040
Niles Werkzeugmaschinen GmbH	N-7036
Normac Inc.	N-7514
Northfield Precision Instrument	W-1251
Oak Ridge National Laboratory	N-7178
Oelheld US	N-6668
Oerlikon Balzers USA Inc.	W-2283
Paulo Products Co.	N-6068
<i>Power Transmission Engineering</i>	N-7148
Process Equipment Co.	N-6133
QC American LLC	N-7027
R.P. Machine Enterprises, Inc.	N-7030
Rattunde Corporation	N-6737
Reishauer Corporation	N-7018
Richardon GmbH	N-6918
Riten Industries	W-1336
Roeders of America	S-8017
Roto-Flo	N-7115
S&T Dynamics	N-7425
S.L. Munson and Co.	N-7240
Saacke North America LLC	N-7329
SAMP S.p.A.	N-6924
Sandvik Coromant	W-1500
Schiess Brighton GmbH	S-8275
Schunk Inc.	W-2000
Seco Tools Inc.	W-1564
Setco	N-6520
Sicmat S.p.A.	N-6924
Siemens Industry Inc.	E-5010
SKF USA	E-5842
SMW Autoblock	W-1400
Solar Atmospheres	N-6414
Solar Manufacturing	N-6414
Speedgrip Chuck-Cameron-Madison	W-1496
Star SU LLC	N-6924, W-1385
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Sunnen Products Co.	N-7400
The Timken Co.	N-7190
Ty-Miles, Inc.	N-7127
Tyrolit GmbH & Co. KG	N-6918
U.S. Gear Tools, Inc.	N-7115
Wenzel America Ltd.	E-5261
WFL Millturn Technologies GmbH & Co. KG	S-8566
Winterthur & Wendt	N-7063
Wittenstein	E-5386
Zoller Inc.	W-2022





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# IMTS 2012

## Events, Conferences and Some Just Plain Fun

Photos courtesy of IMTS

**IMTS exists primarily as a buy-and-sell North American venue for practically every conceivable technology used in manufacturing,** and in that regard it has no equal. There you'll find on display the latest and greatest technology, from hardware to software and everything in between.

But anyone who has attended past shows is aware that IMTS is much more than that. Following is a run-

down of "extracurricular" activities you'll find waiting for your edification and enjoyment. After all, it's not *all* work; some playtime is also in the offing.

But first a mention of a very useful show resource you'd be foolish to ignore—i.e., the *IMTS MyShow Planner*. It goes without saying that IMTS is a huge show. And since roller skates, mopeds and the like are forbidden on the show floor, the *Planner* is a tool created to ensure time well spent as you make the rounds.

Simply go to the IMTS site and cre-

ate your free account. With the *Planner* you can:

- Optimize your time by quickly locating the exhibitors and products you want to see before arriving at the show.
- Locate new companies with services and products you may not have even been aware of.
- Keep track of sessions you'll be attending and appointments you've scheduled on your own personal calendar.
- Contact exhibitors before the show begins.
- Log back in after the show is over to remind yourself which exhibitors you visited and what they were displaying at this year's show.

Now, on with show (*Ed's note: please be advised that sign-up deadlines, etc., for these events are time-sensitive and may have passed by press time. Check the IMTS site—IMTS.com—for the latest information*).

**Manufacturing and Technology Manufacturing Stage (Grand Concourse; Level 3).** The Manufacturing Stage is the epicenter of the morning activities at IMTS 2012. The show starts with an opening ceremony on Monday, September 10th with Douglas Woods, president of AMT and Jay Rogers, president, CEO and co-





founder of Local Motors, unveiling the newly built IMTS Rally Fighter, followed by a government representative for the manufacturing industry. Tuesday, Thursday and Friday will feature Harry Moser, founder of the Re-Shoring Initiative, who will discuss his latest efforts in bringing manufacturing back to the U.S. Also, be sure to check the schedule on *IMTS.com* for updates and additions to the Manufacturing Stage.

**Today's Technology Center (Booth W-100; West Building).** GIE Media, Inc. brings an exciting line-up of aerospace, automotive, medical and power generation products to the Today's Technology Center booth in the West Building, including:

- 1903 Wright Flyer—fly an exact replica via simulator
- Unmanned air vehicles (UAVs)
- Buckeye Bullet—an electric race car powered by fuel cells that has set international land-speed records of 303 mph
- SynDaver—a synthetic human body that bleeds, breathes and employs hundreds of replaceable muscles, bones, organs and vessels
- A vertical-axis wind turbine suitable for installation on rooftops in urban areas

**Advanced Manufacturing Center (Booth W-160; West Building).**

The Advanced Manufacturing Center is a must-visit. This technology-centered display will feature the Boeing Fuel Cell Demonstrator Aircraft; a Lotus Formula 1 Race Car (as well as metal and carbo-fiber car components displayed by Lotus); the Virtualis Virtual Reality Theater; multimedia displays from *Modern Machine Shop*; *MoldMaking Technology*; *Production Machining*; *Automotive Design & Production*; *CompositesWorld*; and *TechSpex*. *Modern Machine Shop's* "The Shop" will offer networking and learning opportunities for attendees and exhibitors in a private, informal lounge environment. In addition to the hands-on, high-end technology on display, visitors can register to win one of four Kobalt 16-drawer, 53-inch stainless steel tool chests.

**Emerging Technology Center (Booth-650; North Building).** The

Emerging Technology Center (ETC) made its debut at IMTS 2004 as a place to educate, inform and excite the manufacturing community about groundbreaking innovations specific to the industry. The ETC has become a fixture at IMTS and is world-renowned for showcasing state-of-the-art and disruptive technologies that will impact manufacturing in the years to come. At IMTS 2012 the ETC will highlight four technologies: collaborative manufacturing; additive

manufacturing; MTConnect applications; and MTInsight.

**For Job Seekers and Job Fillers**  
**IMTS Job Center/Trillium CNC (Booth W-200; West Building).**

Whether you are in search of top-level talent for technical manufacturing positions or are a skilled machinist seeking your next career challenge, stop by the IMTS Job Center.

**Looking for Top-Level Talent?**

The experts from Trillium CNC/CNC Jobs, with over 28 years of ex-

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perience in technical recruitment and staffing, will be on hand to offer advice on how to obtain, market to and secure top-level talent for technical positions. As the battle to find skilled talent in manufacturing continues, it is more important than ever to have access to the tools and expertise that can help you attract and maintain a highly skilled workforce. Trillium CNC/CNC Jobs is a national leader in technical staffing, with over 5,000 clients nationwide.

**How to prepare.** Compile a list of positions that you are actively looking to fill or may need to fill in the near future, be sure to gather job descriptions and skill requirements as well.

**What to bring.** Job listings, job descriptions and a business card.

**What to expect.** The opportunity to speak with industry experts on the best ways to attract and screen the strongest candidates for your technical manufacturing positions. Advice will be provided ranging from recruitment, advertising and screening to employee recognition.

### Seeking Top Technical Manufacturing Careers?

Are you skilled in technical manufacturing and looking to land a new career? Visit booth W-200 to meet with recruiters and head hunters who will be available for resume writing tips, interviewing advice, and career guidance. Whether you are looking to re-enter the workforce or upgrade from your current position, come receive the advice and tools needed to help you negotiate a competitive wage, benefit package, and land the job against other skilled candidates. Let's face it, it's not about finding a job; it's about finding the right career for you.

**How to prepare.** Create a basic resume including previous work history and your contact information. Create a reference sheet including names and contact information for previous supervisors. If you need immediate career search assistance, register at [www.trilliumjobs.com](http://www.trilliumjobs.com) to view some opportunities.



**What to bring.** Your resume and reference sheet.

**What to expect.** The opportunity to speak with industry recruiting experts in regards to your career ambitions, resume writing and interviewing techniques, and salary and benefits negotiation tips.

**NIMS Student Skills Center (Hall C; North Building).** The NIMS Student Skills Center is a free, week-long event at IMTS 2012 and is a one-of-a-kind opportunity for students, educators, school administrators and guidance counselors to gain a first-hand glimpse into in the world's



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**N-7245**

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most cutting-edge technology for the purpose of reinforcing a nationwide increase of STEM education at the secondary and post-secondary level. The Student Skills Center will feature the Careers in Welding Trailer, sponsored by Lincoln Electric, which will contain five simulators as well as interactive exhibits designed to excite young people about careers in the welding industry.

A trip to the NIMS Student Skills Center is a ticket not just to IMTS, the largest manufacturing technology show in North America, but a chance to stimulate technical interest in young people, to eliminate antiquated stereotypes of STEM-related careers, and to bridge the gap between education and industry so that students are provided the skills needed to pursue well-paying, highly technical careers that go beyond the stereotypes.

**Town hall meeting: Shop Floor Workforce Shortage (Booth N-6677, Tuesday 9/11 at 11:00 a.m.)**. IMTS attendees will have the opportunity to sound off about facing the challenge of finding engineers, designers and qualified machinists, welders and other workers to fill the open positions in U.S. manufacturing plants. Greg Jones, vice president, Smartforce Development, will anchor a panel of industry executives for a town hall-style, two-way discussion about programs and projects that are



working, while also exploring new ideas to help solve this issue over the long term. This is your opportunity to make a difference and join in to listen, learn and have your voice heard on this important topic.

### Emerging Relevance of Social Media to Manufacturing

**What's all this about social media and where do I start?** This program will provide an informative, real-world explanation of social media by providing simple analogies and anecdotes to provide a better understanding of what's happening and how to understand it. This presentation will provide the "50,000-foot" overview of

social media and conclude with giving participants some places to start regarding social media efforts for their company.

**Social media—not your typical manufacturing technology.** This isn't your father's machine shop. Curious how social media plays a part in your business? Come and see why social media is important to U.S. industry in showcasing manufacturing technology as the high-tech, advanced industry it is.

**Like us on Facebook? Now what?** An analysis and discussion of four global machine tool manufacturers' approach in their first year of an integrated social media and digital communications strategy. This includes a comparison of the different companies' evolution as they embraced new media with a variety of actual examples.

**What the Marine Corps can teach you about LinkedIn.** This program provides an overview of LinkedIn by starting with the premise that "every Marine is a Rifleman," therefore everyone within your company is a salesperson, regardless of job description. (This program is dedicated to Fox Company, 2nd Battalion, 7th Marines. They held a position known as "Fox Hill" from Nov. 27 to Dec. 2, 1950 that enabled the 5th & 7th Marine Regiments to withdraw from the Chosin Reservoir. Of the 220 men in Fox 2/7, just 82 survived. Their gal-





lantry saved 8,000 Marines from certain death or capture.)

**Program details:**

Why it's critical

- Completing your LinkedIn profile correctly
  - Why your interests, hobbies, affiliations and groups are important
  - Leveraging LinkedIn for your company
  - Team-building opportunities with LinkedIn
  - Connecting it to other social media
  - How it relates to SEO
- Key concepts:
- The 4 Cs of social media (abridged)
  - "Social" in the context of history (pictured)
  - Understand how different generations communicate
  - IMTS reception conversations are just like social media
  - "Nuts-and-bolts" overview of blue-printing a strategy
  - "Nuts-and-bolts" overview of "branding" via social media
  - "Nuts-and-bolts" tactical implementation by social platform

**How can social media really help you?** See how to gain insight into



your customers' true wants and needs. Discover how listening to on-line conversations enables your product development team to meet the needs of your customers.

**Ignorance is not bliss.** You've heard it over and over again—that conversation about your brand is happening whether you like it or not. And it's true. Use social media to turn critics into advocates. Some of the skills needed to manage sticky



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conversations and a walk-through scenario of what happens if you do nothing are presented.

#### **Connecting with “millennium.”**

The future employees of our industry—“millenniums”—are the hottest, most discussed topic for discussion. Come and learn about available tools to connect with students today who are armed with smart phones, don’t use e-mail and are socially active online. Learn who these millennials are and why they want—or don’t want—to work in our industry.

**YouTube: How small companies can be more effective than big companies.** This program provides an overview of YouTube functions as well as how and why it’s imperative that metal-cutting and metal-forming manufacturing companies use this service to tell their story. For discussion:

- How big is YouTube?
- How did it get built and why is it important to social media?
- Why selecting a user name is important.
- Marketing on other “channels.”
- What to share.
- How to share.

#### **Getting on target with Twitter.**

This program is designed to introduce Twitter and how it can be used for B2B selling in the manufacturing industry. The presentation focuses

on how machine shops, manufacturing companies and metal-cutting industry professionals can leverage their relationships to help promote their business, as well as stay on top of the market conditions in their industry segment. Subject matter will delve into information not only based upon their industry forte (medical, aerospace, automotive, defense and electronics) but also their material specialties (nickel alloys, non-ferrous, ferrous).

**How can I really help my customer?** We’ll demonstrate how to gain insight into your customer’s true wants and needs. Let us show you how listening to online conversations enables your Product development team to meet the needs of your customers. How can you solve a problem once and for all?

**IMTSedu/IMTS 2012.** (Booth N-6677; North Building). Justin Post (Map Your Show), Greg Jones (AMT), Bernard Martin (RPM Consultants) and Mike Magan (dgs Marketing Engineers) are just some of the experts on-hand to provide you with ideas and suggestions that you can put into action immediately using the laptop stations within the booth. Learn the tips, tricks and tactics that can help generate business for your company using the social media channels. Determine the economic performance

and status of the manufacturing industry in real time. Speak up at a “town hall” meeting on the challenges facing the current workforce.


### **Fun Stuff**

**Special in-booth events.** The exhibitors at IMTS are bringing their A-game to McCormick Place. They are bringing race cars, card-playing robots, helicopters, planes, machines that dance to music, and more. There are also special presentations and guest appearances, with perhaps a few celebrities strolling the aisles. To ensure you don’t miss anything, there is a daily listing available of the special events taking place in each building during the show.

**Car design competition.** Join a collaborative engineering community through the IMTS car skin design competition. You can help design and select the skin that will appear on the IMTS car to be built in the Emerging Technology Center at IMTS 2012.

**60-second video contest.** Vote for your favorite exhibitor videos.

**IMTS balloon.** Yes, the IMTS hot-air balloon is back; catch it at the front lawn of McCormick Place.

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# GOT A GEAR QUESTION?

## Ask the Expert!

Welcome back to *Gear Technology's* Ask the Expert—a regular feature intended to help designers, specifiers, quality assurance and inspection personnel in addressing some of the more complex, troublesome gearing challenges that never cease to materialize—whether on the drafting table or the shop floor. Simply email your question—along with your name, job title and company name (if you wish to remain anonymous, no problem)—to: [jmcguinn@geartechnology.com](mailto:jmcguinn@geartechnology.com); or, you can submit your question by visiting [geartechnology.com](http://geartechnology.com).

### QUESTION #1

#### Refurbishing a Ball Mill

We are refurbishing an Allis Chalmers ball mill. The herringbone bull gears and pinion gears are worn. Can these gears be reversed?

Can herringbone gears be reversed?

The answer is yes—but both pinion *and* gear must be reversed.

By reversing only one member, the set will not match because the gear and pinion will have the apex running in the same direction.

Also, by reversing both members, we are assuming the set can be reversed from a dimensional standpoint.

I cannot tell you if dimensional issues will be a problem without seeing drawings.

Please feel free to call OCG if you have further questions. Once we see drawings and better understand the application, we can provide a more definitive answer.

**Frank Romans** is vice president of sales & marketing for Overton Chicago Gear. He can be contacted at (630) 543-9570, Ext. 305, or at [fromans@oc-gear.com](mailto:fromans@oc-gear.com).

### QUESTION #2

#### Bevel Gears: Backlash/Contact Pattern Optimization

It is very difficult to set by trial-and-error a pair of bevel gears for ideal backlash and contact pattern for regular, on-site gear technicians, as it involves lot of time for assembly. We have to bring in professionals—even after paying high charges for spares. Is there a faster/easier mode to arrive at an ideal combination?

Assembling bevel gears by trial-and-error is exactly the wrong way to go!

Properly made bevel gears should have their backlash and mating teeth marked on them—as well as the mounting distance each part has to be at—(in order) to obtain the backlash and no-load contact pattern. The mounting distances are meant to be used. You should measure your components and calculate the shims necessary to properly position each gear. Assemble the gears with the mating teeth engaged using the calculated shims. Only after doing that should you check backlash; it should agree with the markings. If it does, you should be OK; if not, you have made a mistake.

Backlash must be measured the same way the manufacturer did. On straight bevels, that is at the pitch diameter in

the plane of rotation. But on spiral bevel and hypoids, the backlash is measured normal to the tooth surface. If you can do that directly on the gears, you can use the same number. If you have to do that outside of the gear box, you have to convert that number from the normal plane to the transverse plane—i.e., the plane of rotation. You will need to know the manufacturing cutter diameter and some of the gear geometry to do that.

That was the simplified answer.

How do you calculate the shims? How do you calculate the backlash in the plane of rotation? Both of these subjects have been carefully thought out and published by the AGMA Bevel Gearing Committee in *ANSI/AGMA 2008-D11: Assembling Bevel Gears*. There are photos and illustrations for examples of the methods and

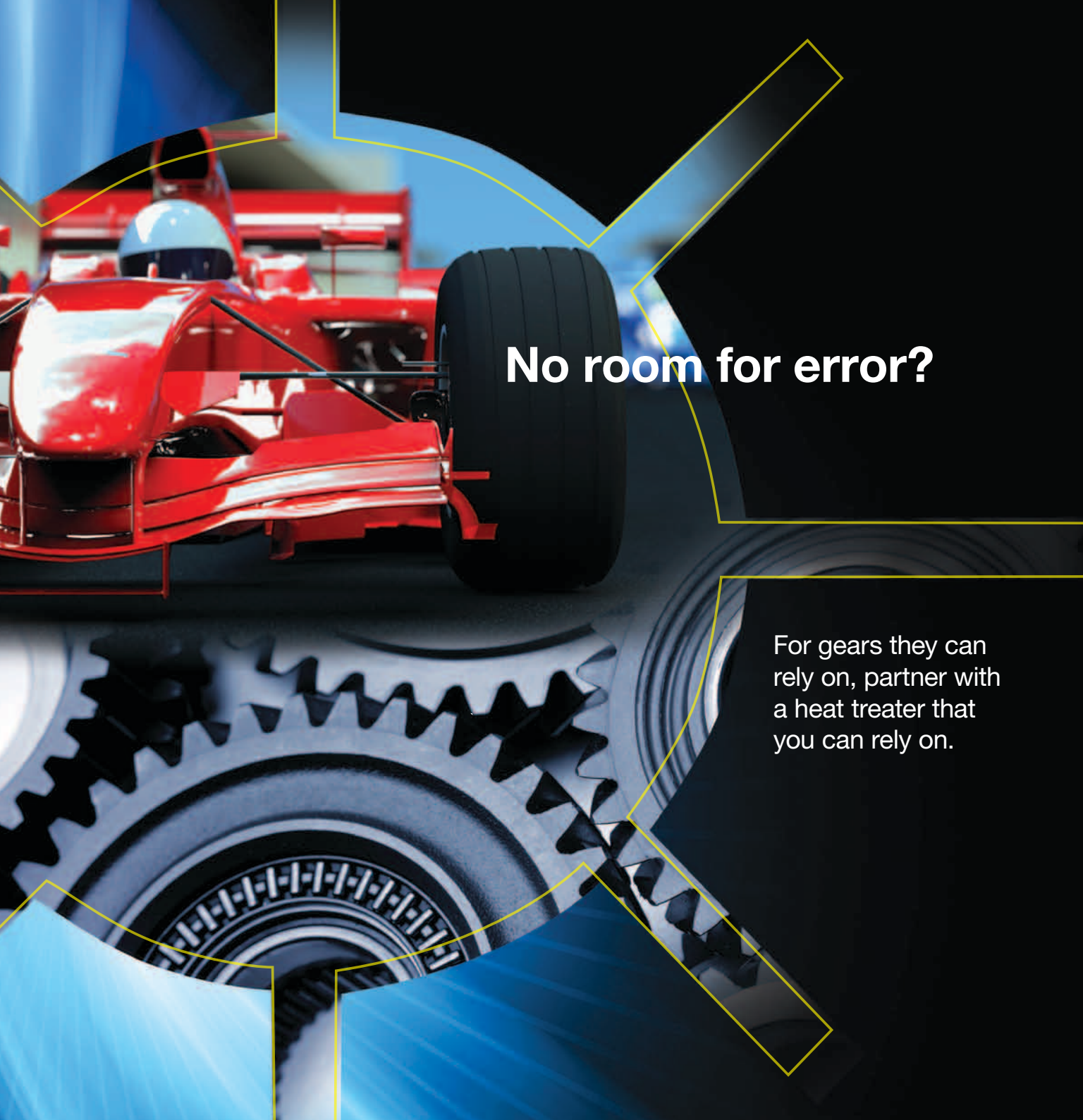
sample tooling used to assist in determining proper values. Images of incorrect patterns and the changes necessary to correct them are also included. There is even a detailed color photo annex with directions on how to take a contact pattern check if you really need to.

Far too much detail to be included in this limited description. You can purchase that document at: [www.agma.org](http://www.agma.org) (AGMA members—\$37; non-members—\$74.)

**Robert F. Wasilewski**  
*design engineering manager*  
*Arrow Gear Company*

**Robert F. Wasilewski** is design engineering manager at Arrow Gear Company, chairman of the AGMA Bevel Gearing Committee and a member of the AGMA Technical Division Executive Committee.





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# How Bearing Design Improves Gearbox Performance

Armel Doyer

Gearbox performance, reliability, total cost of ownership (energy cost), overall impact on the environment, and anticipation of additional future regulations are top-of-mind issues in the industry. Optimization of the bearing set can significantly improve gearbox performance.

## Introduction

Gearbox efficiency is a topic of rising interest amongst both manufacturers and end-users due to an increased sensitivity to gearbox performance, reliability, total cost of ownership (in relation to energy cost), overall impact on the environment, and also anticipating future regulations.

A gearbox is by nature a quite efficient asset and as such, it has not been subjected to the same debate regarding energy efficiency as other machine components, such as electrical motors. However, due to the increased awareness of environmental impact and the increased energy costs, the optimization of energy is becoming a topic of greater importance also for industrial gearboxes. Looking at the high power/torque transferred by the system, it is of interest to minimize

the losses in terms of absolute values (1 percent of 1 MW is still 10 kW). This is especially valid, when existing technology allows it at reasonable cost and without adding complexity.

As there is a competitive advantage to give the maximum possible output mechanical torque in a given gear unit size, there will be a growing competitive race for manufacturers to show the highest thermal rating for a given size (Figure 1). Energy efficiency is increasing its importance among selection criteria.

In this paper, the author will give:

- Recap of gearbox inefficiency sources
- Overview of latest bearing friction model
- Information on latest tapered bearing technology

- How this can affect gearbox performance via single-stage gearbox example

## Gearbox Efficiency, Inefficiency and Thermal Rating

As most technicians and engineers learn at school, a gearbox is by its nature an efficient asset. A parallel shaft gear unit typically experiences losses of just 1–2 percent per stage (Ref. 1). Example: a single-stage gearbox could have a nominal efficiency of 98–99 percent.

The losses are of different types/sources:

- Gear losses
- Lubrication losses
- Seal (when present) losses
- Windage losses (high-speed gears)
- Bearing losses

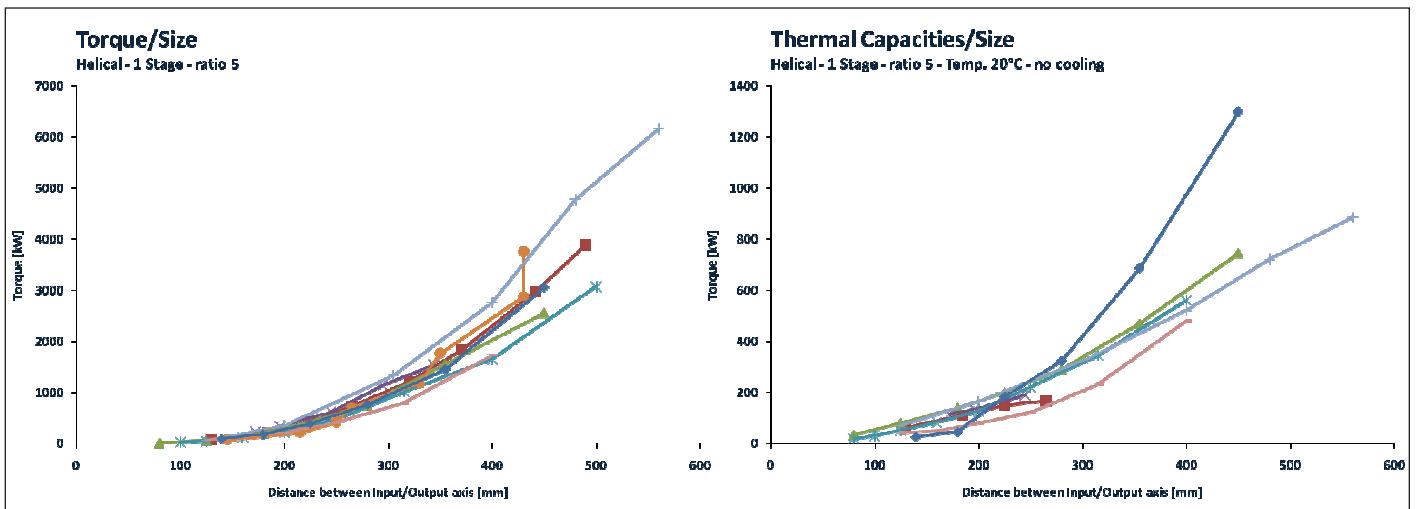


Figure 1 Mechanical and thermal power ratings of single-stage helical gear ratio 5 for various sizes and gearbox manufacturers.

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Many authors have already described some of these losses and the overall behavior of the gearbox (Refs. 1–3). Those authors showed also that the problem is quite complex, especially because a gearbox is a system where losses interact/influence each other due to the thermal equilibrium/heat dissipation.

An ISO technical report (Ref. 4) published a decade ago lists guidelines for calculating the gearbox thermal rating, which is another term to describe efficiency. The advantage of this rating is that it can be compared with the mechanical rating of the gearbox, and thus the user can quickly see when either a cooling solution needs to be added or improved, or the gearbox size needs to be altered.

Most people believe that the gear losses are the dominating ones. While this is true in many cases, it depends on the gearbox design and load cases (Refs. 2–3). With today's sophisticated engineering software, detailed gearbox analysis has become much simpler, faster and accurate than before; it can help designers (and users) optimize and better understand their system. In doing so, they will learn that the relative importance of different losses can vary significantly, and that losses other than gear losses cannot be neglected in the analysis.

As an example, the author's studies have shown that bearing loss can range from 30–50 percent of the total losses—or nearly equal to the gear losses—depending on the applied loading. When a gearbox is used at the level of its nominal mechanical rating, gear losses tend to be dominant, which is expected.

It is also interesting to note that the split between the different shafts is not equal. Depending on gearbox design, the gearbox ratio, bearing load and speed will vary. As illustrated in Figure 2, one may find cases where the input shaft positions are a major source of bearing loss; others, where the output and intermediate positions are the ones generating the highest bearing losses.

In order to optimize the relevant part of the gearbox, it is therefore important to use and understand the latest knowledge and models regarding bearing friction.

### SKF Friction Model

In 2003 SKF published a new bearing friction model in its general catalogue (Ref. 5), (Table 1). This model is based on four sources of friction:

$$M = M_{rr} + M_{sl} + M_{seal} + M_{drag} \quad (1)$$

where

- $M$  is total frictional moment, N-mm.
- $M_{rr}$  is rolling frictional moment, N-mm.
- $M_{sl}$  is sliding frictional moment, N-mm.

$M_{seal}$  is frictional moment of the seal (s), N-mm.

$M_{drag}$  is frictional moment of drag losses, churning, splashing, etc., N-mm.

This new approach (Ref. 6) identifies the sources of friction in every contact occurring in the bearing and combines them. In addition, the seal contribution and additional external sources can be added as required to predict the overall

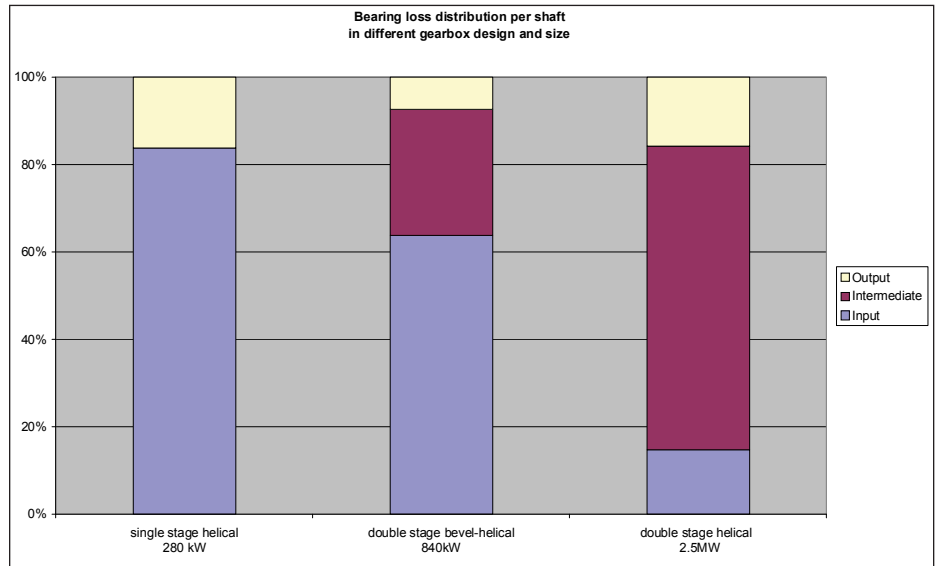


Figure 2 Examples of possible distribution of bearing loss per shaft in different gearbox setup (per SKF investigations).

Table 1 Comparison of philosophy: previous model load-depend/load independent, and new SKF model — four sources of friction			
Old model		New model	
$M_b = M_0 + M_1 + M_2 + M_3$		$M = M_{rr} + M_{sl} + M_{drag} + M_{seal}$	
$M_0 = 10^{-7} f_0 (vn)^{2/3} d_m^3$	Load-independent part (mainly rolling)	$M_{rr}$	rolling friction moment (raceways)
$M_1 = f_1 P_1^a d_m^b$	Load-dependent part (sliding correction)	$M_{sl}$	sliding and spinning friction moment (flanges, raceways)
$M_2 = f_2 F_a d_m$	RB axially loaded (sliding flanges)	$M_{drag}$	oil bath, large bath
$M_3 = \left(\frac{d+D}{f_3}\right)^2 + f_4$	Sealed bearings	$M_{seal}$	friction moment due to seal

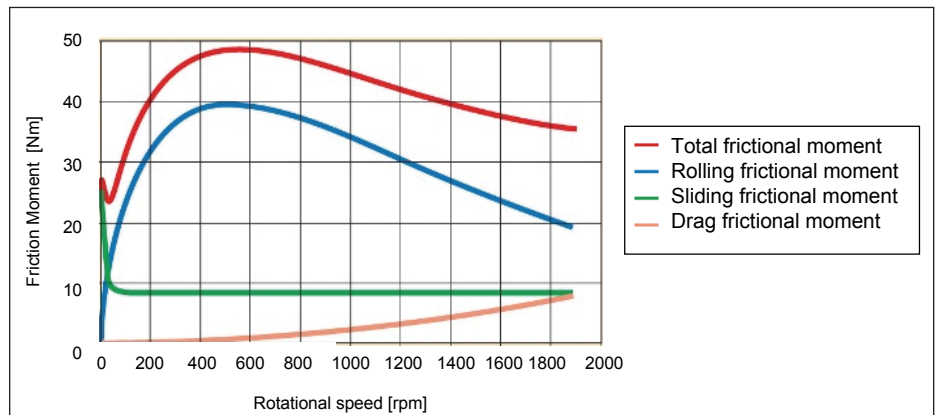


Figure 3 Example of four sources of distribution in a spherical roller bearing with oil bath and thick oil.

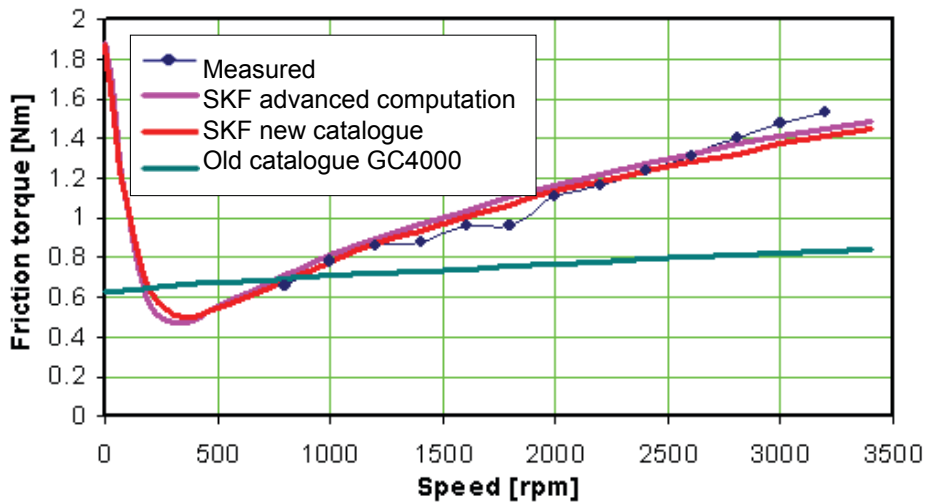


Figure 4 Model prediction and measurement—tapered roller bearing.



Figure 5 SKF energy-efficient tapered roller bearing.

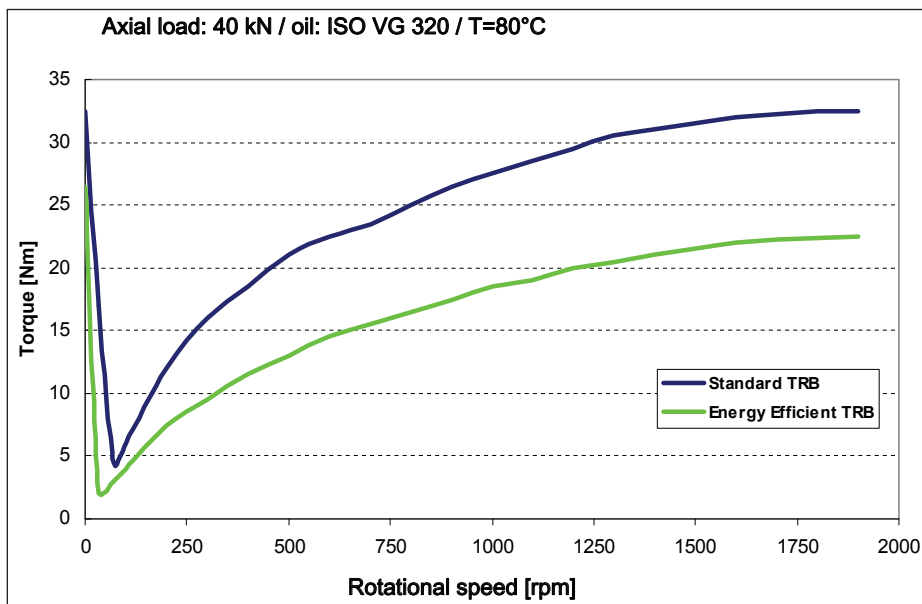


Figure 6 Frictional moment of SKF energy-efficient tapered bearing vs. SKF standard design.

frictional moment. Since the model looks into every single contact (raceways and flanges), changes of design and surface improvements can readily be taken into consideration, rendering the model better able to reflect improvement in SKF bearing designs.

This four-source model allows the designer to understand in detail the conditions under which the bearing functions internally. For example, in Figure 3 the four sources of loss are plotted as a function of speed; it can be checked where the bearing losses are driven by rolling or sliding sources.

In addition, Figure 4 shows that the new friction model accommodates bearing friction measurement (here on tapered roller bearing) over the speed range.

Using this new model will allow gear user and designer to make better predictions and provide a better understanding of the bearing losses in a gear unit over various loading conditions. Thus, it allows improved optimization of the system by providing a more accurate comparison between different bearing types and designs.

### Energy-Efficient Tapered Bearings

With this improved understanding of friction behavior and a better friction model, SKF was able to develop a new generation of tapered roller bearing (Ref. 7), (Fig. 5), or energy-efficient bearing. These bearings generate 30 percent less friction than conventional tapered roller bearing designs in most loading conditions (Figs. 6 and 7).

Many bearing design parameters were reviewed and optimized to realize this friction saving, and without compromising the fatigue life of the bearing. For example, the new design has some specific flange geometry, reduced recess and extended inner ring raceway. Moreover, special raceway profiles and roller topographies in conjunction with reduced roughness of the ring raceways and flange have been adopted. A special cage with reduced bore diameter—preferably made of PEEK or, for special demands, sheet steel—has been developed.

The most visible change was a reduction in the number of taper rollers. For bearing type 32230 J2, the roller set has been reduced by four. With the reduced



number of rollers, the rotating mass decreased by approximately 10 percent.

The reduced number of rollers also has a major influence on lubrication. Fewer rollers mean less friction and mechanical working in the lubricant. This leads to lower operating temperatures, which in turn improves the separation of the surfaces in rolling contact through better lubricant film formation, and this extends lubricant life.

Thirty percent less friction is a quantifiable improvement, but the question for a gearbox designer and user is this: What does it imply for the gearbox performance, in terms of thermal rating and life performance? In the next section, a simulation example of a gear unit is given.

### Impact on Gearbox via Single-Stage Gearbox Example

A single-stage helical gearbox was selected for the analysis. This gearbox has a mechanical power of 280 kW and a thermal rating of about 50 kW. The reduction ratio is four. This gearbox is equipped with four identical tapered roller bearings (bore diameter 60 mm, series 323). Bearings 1 and 2 are located face to face on the input shaft; bearings 3 and 4 are located face to face on the output shaft.

The analysis was performed in two steps:

1. A preliminary analysis in which bearing losses and temperatures are calculated based on gear loads and speed effects (no other loss interaction).
2. A complete analysis in which all losses are taken into account — gears, bearings, oil splash.

Both analyses consider the preload/clearance case of the bearings, as it has an important role on the bearing friction itself.

**Preliminary analysis.** In this first step, the impact of the new bearing design was evaluated only by taking into account bearing-generated heat, and not the heat equilibrium from other losses. This first analysis is very quick and easy to perform and allows one to understand the bearing behavior trends without external influences. It also provides an approximate indication of the loss split per shaft and potential impact of a bearing design change. In any case, it will not yield an accurate prediction of the real perfor-

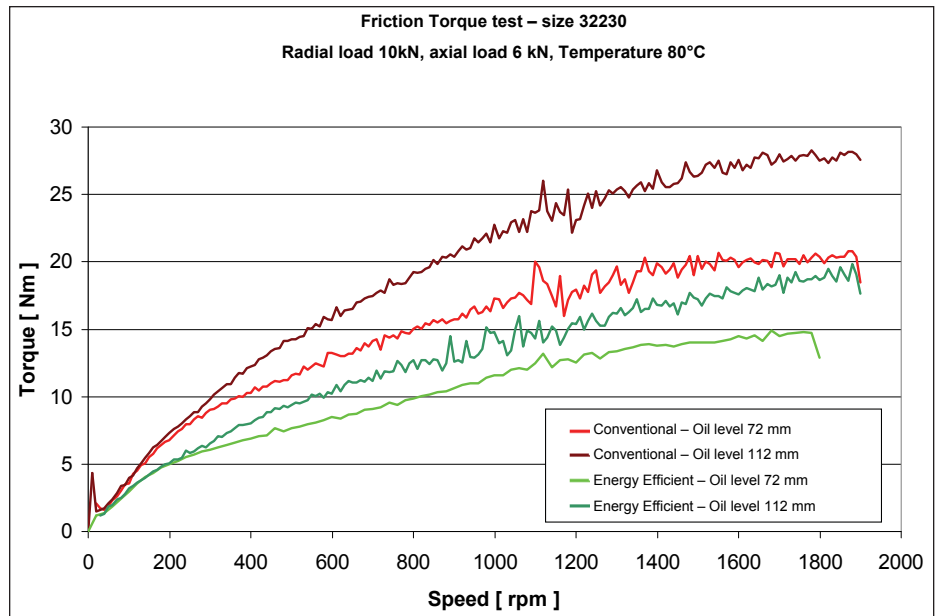


Figure 7 Frictional moment of SKF energy-efficient tapered bearing vs. SKF standard design—different oil level.

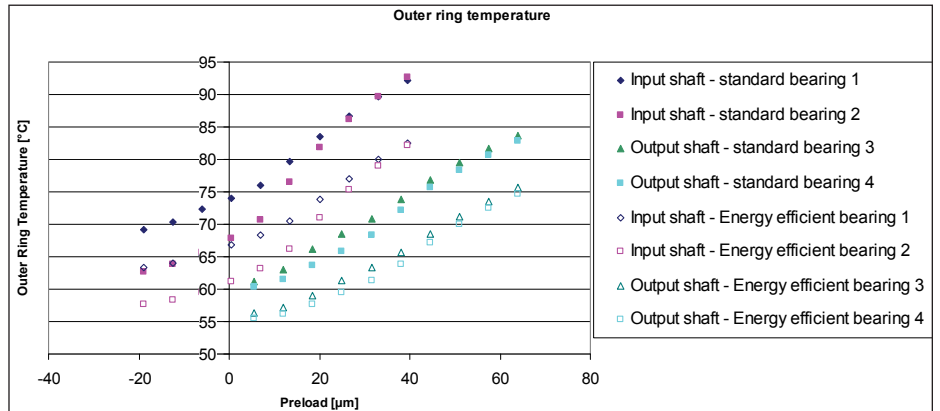


Figure 8 Detailed comparison of outer rings temperature—energy-efficient vs. standard—dependent on preload (bearing losses only).

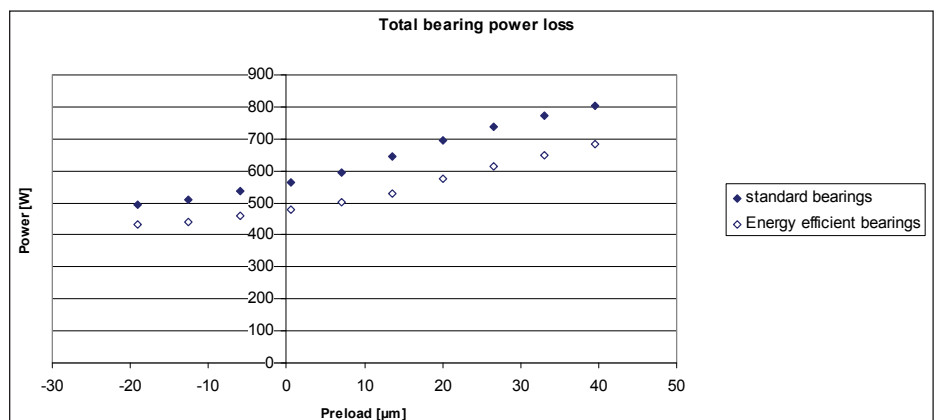


Figure 9 Comparison of the sum of the bearing losses—energy-efficient vs. standard—over the preload range (bearing losses only).

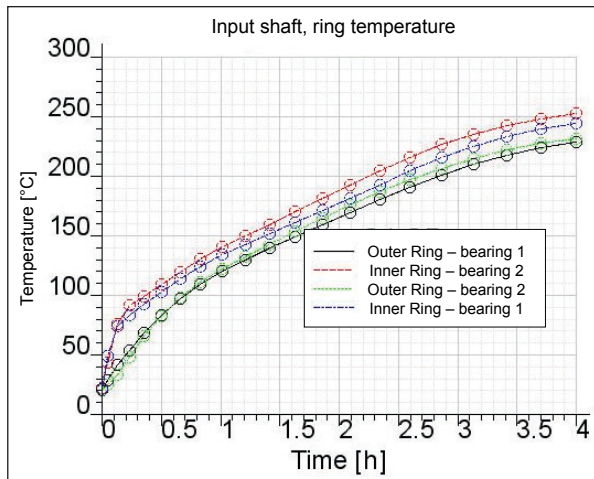


Figure 10 Loss distribution in gearbox dependent on applied torque — standard bearings.

Table 2 Average loss and temperature saving — energy-efficient vs. standard		
Loss source	Standard [W]	E2 [W]
Gear	296	296
Bearing	540	435
Oil splash	156	156
Total	992	887
=> Average saving		10°C and 75W

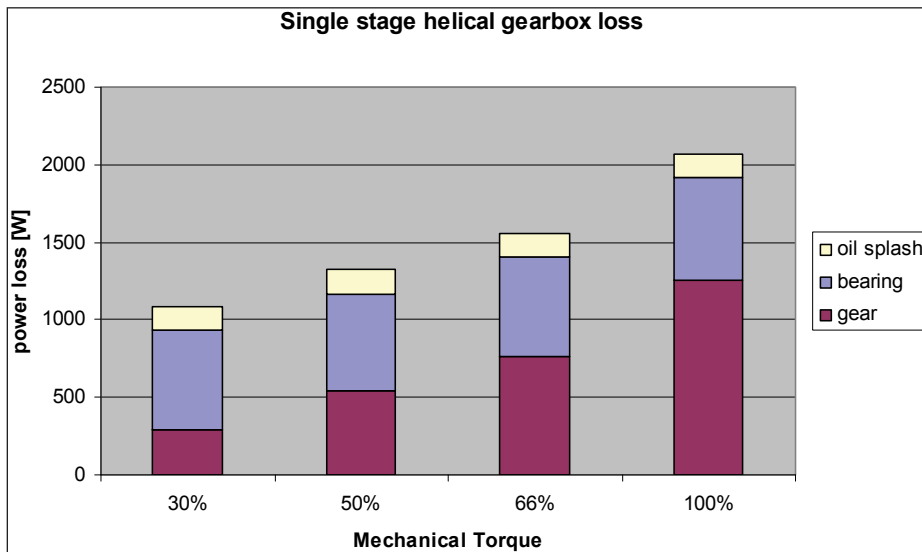


Figure 11 Transient temperature simulation results — at full mechanical load — for input shaft bearing rings.

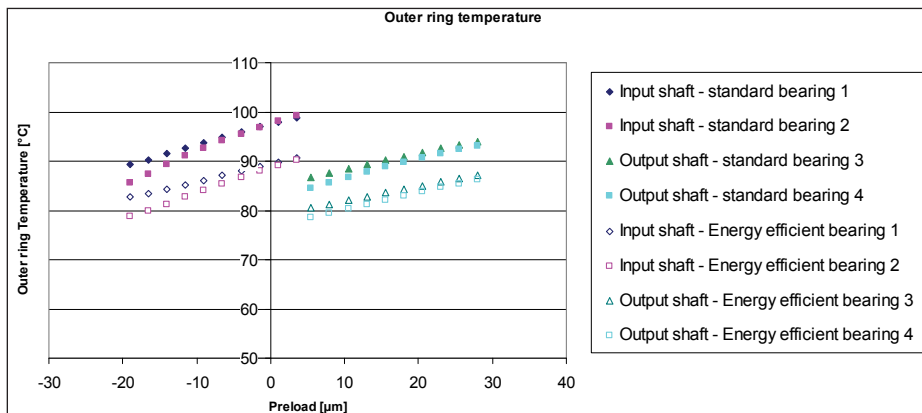


Figure 12 Detailed comparison of outer rings temperature — energy-efficient vs. standard — dependent on preload.

mance, as one doesn't take into account the overall heat equilibrium; such results would be more optimistic than the reality.

The detailed results are presented in Figures 8 and 9; the preload effect is very clear on each shaft.

On average — and in comparison with the standard bearing type — the SKF energy-efficient tapered roller bearing design will:

- Save 60–120 watts (power losses reduced by 13–15 percent).
- Run 4–10°C cooler (each position runs cooler).
- Have a longer fatigue life in most cases, due to better lubrication conditions (higher Kappa): min life L10mn > 100,000 hrs (following SKF rating life method).

This first analysis indicates good trends: the 30 percent less friction achieved with the energy-efficient bearing is converted into reduced outer ring temperature and reduced friction when applied in the gearbox. Next to analyze is what it means when taking into account the complete system equilibrium.

**Complete analysis:** The complete analysis was performed including:

- Gear losses according to ISO TR 14179 formulas.
- Bearing losses according to SKF advanced friction modeling tool.
- Oil splash loss according to ISO TR 14179 formulas.

The full gearbox was modeled into the SKF *Orpheus* tool (including the housing). The results analyzed were bearing friction, temperature on the bearing outer ring and bearing life.

As discussed previously, it is interesting to note that gear loss becomes dominant in the highest load case studied. Below 66 percent full torque, bearing and oil splash represent still close to 60 percent of the loss (Fig. 10).

It must also be noted that the gearbox is subjected to forced cooling when power exceeds 30 percent of the nominal load. SKF thermal simulation confirmed that cooling was needed in such a case. Transient simulation showed that heat can increase to unrealistic values if cooling is not applied; at 100 percent load without cooling the heat generated is so high that the simulation would predict a calculated temperature > 250°C (Fig. 11). The housing thermal expansion



leads to additional bearing load (dependent on grounding). Under the calculated assumption, 10–20 kN additional axial load is generated.

Returning to the main study, the load range of interest is close to 30 percent nominal mechanical power, where the gearbox does not need cooling. In this load condition, one can really measure the impact of a new performance class of bearing (Table 2).

In comparison to the standard bearing type, the energy-efficient tapered roller bearing design:

- Saves 90 to 100 watts (power losses reduced by 20 percent).
- Runs 7°C cooler (each position runs 5 to 9°C cooler on the outer ring).
- Has a similar or higher fatigue life in all cases, due to better lubrication conditions (higher Kappa); i.e., min life > 60,000 hrs

Looking further (Figs. 12 and 13), one can see that the energy-efficient bearings generate lower friction and temperature under the same load, as compared to standard design, whatever the preload/clearance.

Bottom line, without major modification, the performance of the gear unit is increased.

One interesting question is to convert this improved performance (reduced friction and reduced temperature) into a higher gearbox thermal rating: How much more power can this gearbox carry with the energy-efficient bearings, keeping all other parameters (losses and heat) at equal level?

According to the presented calculations (Fig. 14), the thermal rating could be increased by 30 percent when using energy-efficient tapered roller bearings. The new thermal rating can be 70kW instead of 55kW.

## Conclusion

It has been demonstrated that the contribution of bearing losses to system efficiency is dependent on the load cases. Even if the bearing is not the primary source of losses, optimization of the bearing set can significantly improve the gearbox performance. The simulation of a single-stage gearbox — with tapered roller bearings — demonstrated that the running temperature of the gearbox can be reduced up to 10°C by using newest-

technology bearings. Such a saving can improve the thermal rating of the gearbox by up to 30 percent.

Using a proper bearing design can significantly improve the performance of a gear unit by virtue of lower running temperature, improved lubricant life, a potentially simplified lubrication system and inherently reduced running cost. ⚙️

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**Armel Doyer** is a mechanical engineer graduated from Technical University of Compiègne (UTC), France in 1999. He joined SKF's development department for deep-groove ball bearings in 2000. Doyer has held various positions within the development department, working predominantly with automotive and industrial applications and contributing to the introduction of the company's energy-efficient bearings. Since 2008 he has been worked as a business engineer within SKF's industrial drive organization, focusing on bearing development for the industrial gear unit market. Doyer is also a member of the AGMA Energy Efficiency Committee.

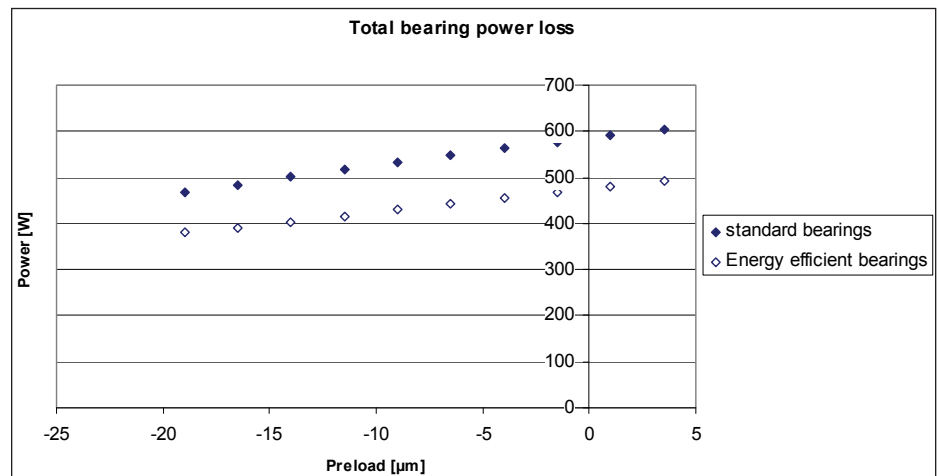


Figure 13 Comparison of sum bearing losses—energy-efficient vs. standard—over preload range.

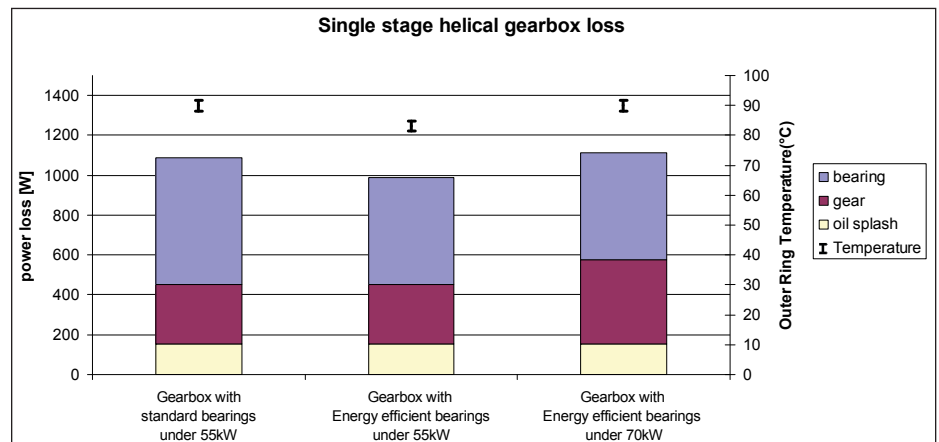


Figure 14 Comparison of total losses and outer ring temperature—standard or energy-efficient bearings—allowing a thermal rating increase.

# How to Minimize Power Losses in Transmissions, Axles and Steering Systems

F.J. Joachim, J. Börner and N. Kurz

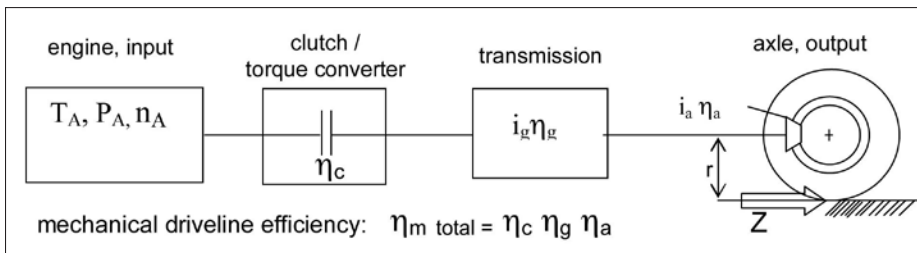


Figure 1 Vehicle driveline efficiency.

transmission		$\eta$ (%)
gear set	spur gear	99.0 – 99.8
	hypoid gear	90 – 93
manual transmission with splash lubrication	car	92 – 97
	truck	90 – 97
automatic transmission (AT, DCT)		90 – 95
CVT mechanical		87 – 93
CVT hydrostatic		80 – 86

Figure 2 Reference values for efficiencies of gears and vehicle transmissions (Ref. 1).

## Management Summary

In today's motor vehicles, an optimally designed driveline provides substantial CO<sub>2</sub> reduction. Different transmission systems, such as manual transmissions, torque-converter transmissions, dual-clutch transmissions, CVTs and hybrid systems, work better with different requirements and vehicle classes. By increasing the number of gears and the transmission-ratio spread, the engine will run with better fuel efficiency and without loss of driving dynamics. Transmission efficiency itself can be improved by: using fuel-efficient transmission oil; optimizing the lubrication systems and pumps; improving shifting strategies and optimizing gearings; and optimizing bearings and seals/gaskets. With the use of lightweight materials and components with a higher specific workload, the torque-to-weight ratio of the transmission can be significantly reduced. Yet in all these areas, further improvements can be expected through use of new lubricants, materials, components and manufacturing technologies; costs and benefits to the customer would naturally be of highest importance.

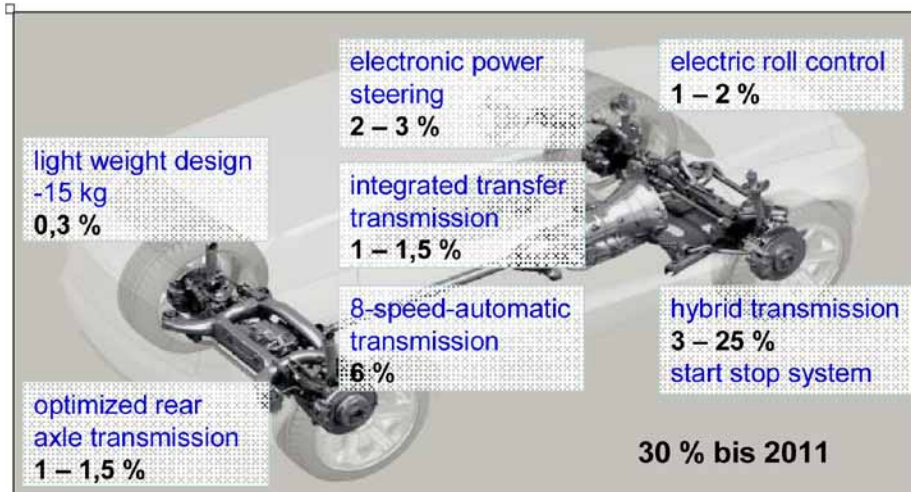


Figure 3 Known potential and limitations of driveline optimization (Ref. 2).

(First presented at the VDI International Conference on Gears, October 2010, Technical University of Munich)



## Introduction

The entire motor vehicle industry is researching possibilities for the reduction of CO<sub>2</sub> emissions. Various factors influence the reduction of vehicle CO<sub>2</sub> emissions—from the engine to aerodynamics, rolling resistance, lightweight design, energy sources and heat management—as well as hybridization and electrification. This article primarily investigates the mechanical optimization possibilities of drivelines and transmissions. The overall mechanical efficiency of the driveline is comprised of the efficiencies of the converter assembly/clutch, main transmission and axle drive (Fig. 1).

Spur gears alone already have a very good efficiency of 99–99.8%. In contrast, bevel gears and, above all, hypoids in rear-axle drives, have a clearly lower efficiency due to their higher percentage of relative sliding (Fig. 2). According to transmission type, efficiency is approximately 85–97% (Ref. 1).

## Development Trends in Drivelines

According to (Ref. 2), there is a theoretical potential for CO<sub>2</sub> reduction by optimizing the driveline and chassis by approximately 60%. This would, however, presume an unrealizable, nearly mass-less and loss-free driveline. In addition, the ratings shown in Figure 3 (Ref. 2) demonstrate a potential increase of approximately 30%; influences on transmission efficiency are listed (Fig. 4). It is necessary here to choose between no-load and load-dependent losses. The current practice is to concentrate on optimization of lubricants, reduction of churning losses, optimization of torque converters and pumps. Investigation of dual-clutch transmissions and which torque values allow for a dry clutch are ongoing.

## Trends in Lubricant Development

Engine and transmission technologies have developed rapidly in recent years. New transmission types—such as the dual-clutch transmission—have gone into volume production.

Existing transmission types were technically improved, with a focus upon optimization of shifting comfort, efficiency and reliability. This, in turn, provided advantages for customers: i.e., improved driving comfort and fuel consumption, and vehicles required less service main-


- kind of lubricant
  - churning losses (viscosity, oil level)
  - gear friction (geometry, surface)
  - clutch, brake, synchronizer (clearance)
  - bearing friction
  - sealings
  - oil pump
  - torque converter
  - oil feed, piston, filter, valves
- 

Figure 4 Influences on transmission efficiency.

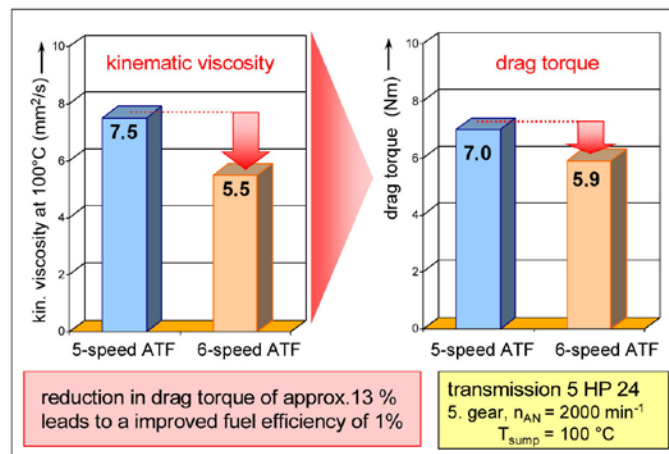


Figure 5 Influence of service viscosity (ATF) on transmission drag losses.

tenance. Engine development has in large part influenced diesel engines in terms of transmission capacity, due to a considerable increase in torque.

Efficiency-optimizing transmission oils are lower in viscosity; with both automatic and manual transmissions, this reduces fuel consumption up to 1% (Fig. 5). According to (Ref. 3), demands on the friction performance in the various friction elements in the respective transmissions are very special. Future viscosity reductions are limited because wear and pitting resistance are critical; also, with the leakage of pumps, etc., with so-called “fuel efficiency lubricants,” all criteria and influences must be checked. Figure 6 shows that the pitting performance for low-viscosity manual-transmission fluids is reduced. Perhaps this negative effect can be compensated by suitable additives.

## Lubricant Efficiency Testing

The frictional behavior of the carburized lubricants plays an important role in the selection of lubricant and oil development. A ZF efficiency test was developed for evaluating the frictional behavior of gearing (Refs. 7 and 11). A gear-wheel four-square test rig, in accordance with DIN 51354, is used with a center distance of 91.5 mm; the principle design is presented (Fig. 7). In contrast to the standard oil test, in the efficiency test the same test gears are installed in the test transmission and actual transmission. A highly precise power measurement hub is installed between the drive motor and the transmission, making it possible to directly measure the power loss introduced in the stress circuit. This approach is significantly more accurate than a measurement of performance difference in an open-stress circuit.

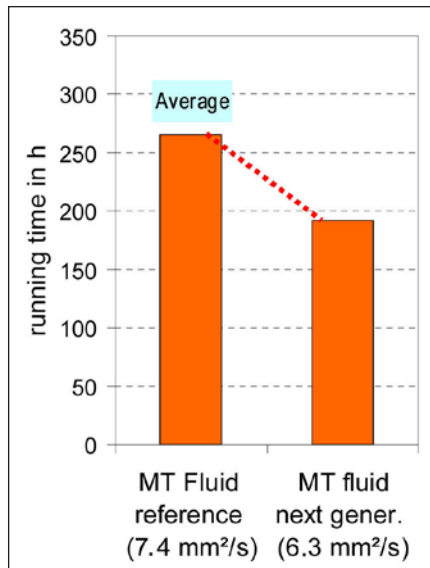


Figure 6 Gear pitting durability for manual transmission oil with lower viscosity (Ref. 3).

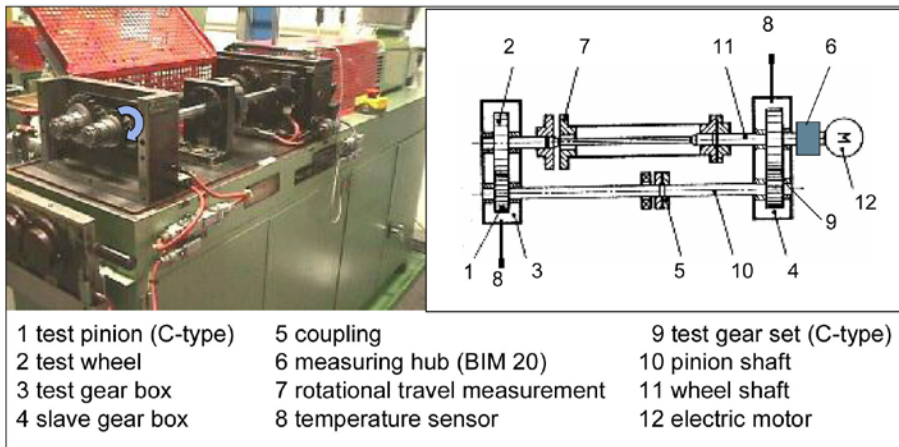


Figure 7 Vehicle four-square test rig (per DIN 51354) for limiting power loss and teeth friction coefficient.

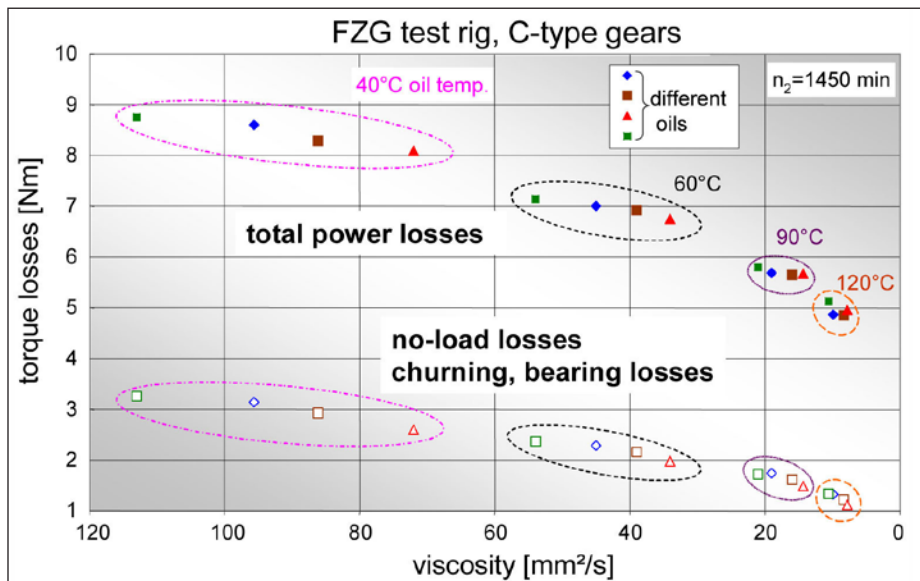


Figure 8 Influence of viscosity and temperature on power losses in FZG test rig.

Alternatively, the torque measurement method used can also be applied to a test rig with variable center distance. It then becomes possible to study the gearing friction behavior of volume-produced gears under practical operating conditions. The ZF efficiency test employs the standard C gearing or, alternatively, a passenger car gearing that is close to volume production. The gear friction coefficients are determined at different rotation speeds and oil sump temperatures. If necessary, the test conditions — circumferential speed, surface stress (torque), lubrication conditions, etc. — can be adjusted directly to the values for each particular case. After a phasing in with a low rotation speed and reduced torque, in the actual measuring run the total power loss  $P_v$  and the corresponding idling power loss  $P_{v0}$  are determined. The total power loss is comprised of the following components:

$$P_v = P_{VZP} + P_{VZ0} + P_{VLO} + P_{VLP} + P_{VD} + P_{VX}$$

where

$P_v$  = total power loss measured under load

Load-dependent:

$P_{VZP}$  = gearing losses

$P_{VLP}$  = bearing losses

Load-independent:

$P_{VZ0}$  = gearing losses

$P_{VLO}$  = bearing losses

$P_{VD}$  = seal losses

$P_{VX}$  = other losses

The load-dependent bearing losses ( $P_{VLP}$ ) are accounted for by virtue of the data provided by the bearing manufacturer in the relevant bearing catalogs. The back calculation of the gear friction coefficient is performed using the following equation:

$$P_{VZP} = P_a * \mu_m * H_v, \mu_m = \frac{P_{VZP}}{P_a} * H_v = \frac{M_{VZP}}{T_1 * H_v}$$

where

$P_{VZP}$  = load-dependent gearing loss

$P_a$  = input power

$\mu_m$  = median gear friction coefficient

$H_v$  = gear loss factor =  $f$  (gearing geometry) (Refs. 12, 14)

Figure 8 shows the measured power losses in the FZG-test-rig with C-type gears. The losses decrease with lower viscosity of the lubricant or with higher oil temperature of the same lubricant. Figure 9 shows the influence of the surface qual-



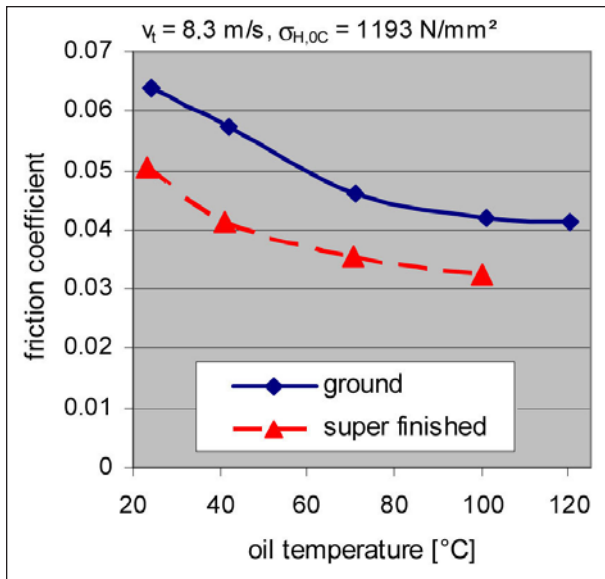


Figure 9 Influence of surface finishing on gearing friction coefficient (oil: Shell Spirax MA 80).

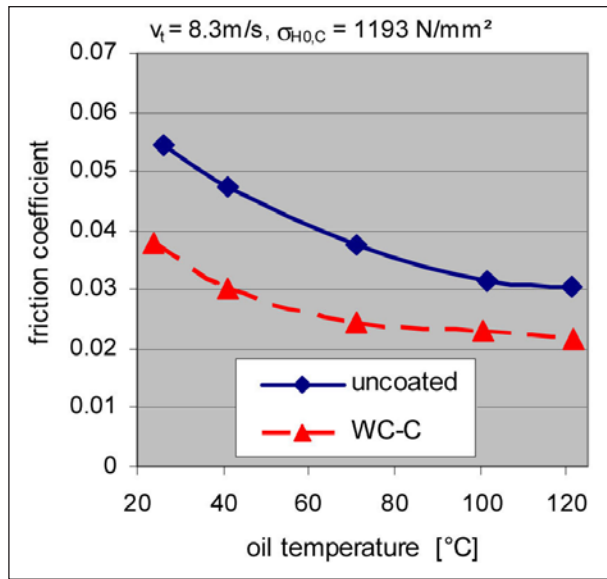


Figure 10 Influence of coating on gearing friction coefficient (oil: semi-synthetic GL4).

ity of the gear flank on the friction coefficient. The friction can be reduced with surface finishing (super-finishing). The friction behavior can likewise be positively influenced by gear flank coating (WC-C; Fig. 10). The corresponding methods for determining the friction coefficient were derived on the basis of extensive investigations. It is thus possible to convert the friction coefficients determined in the ZF gearing efficiency test with good accuracy to other operating conditions in transmissions.

### Calculation of Gear Losses

Simple formulations for the calculation of gearing power losses, such as the loss factor  $H_v$  (Refs. 12 and 14), are based on an assumed load distribution dependent on the number of meshing teeth. The calculation of gearing power losses can be improved if load distribution in the area of contact is considered, which the *LVR* (Ref. 13) program does. This load distribution is usually determined on the basis of deformation influencing variables with a system of equations for the sum of forces in the plane of action. Determination of losses also requires consideration of the frictional forces acting at right angles to the plane of action, for which purpose the system of equations for the balance of torque on the driving gear needs to be formed and resolved. The torque resulting on the output is determined on the basis of the calculated distribution of normal

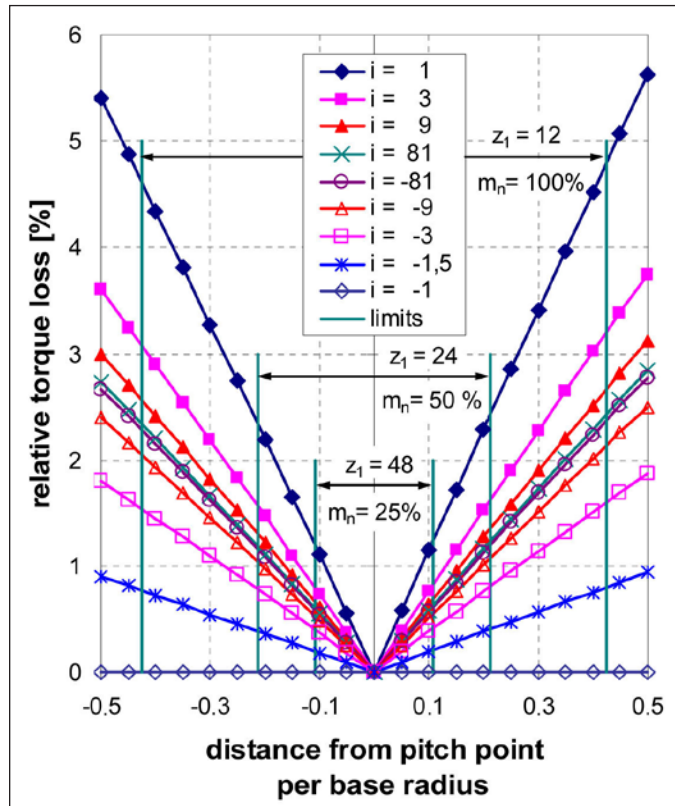


Figure 11 Relative gear loss resulting from tooth friction on path of contact.

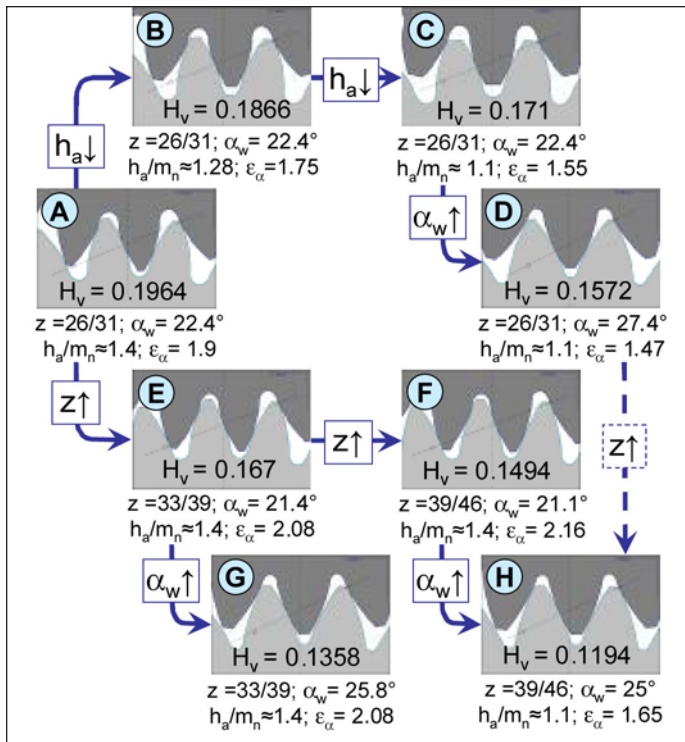


Figure 12 Geometric loss factor  $H_v$  for different gearings.

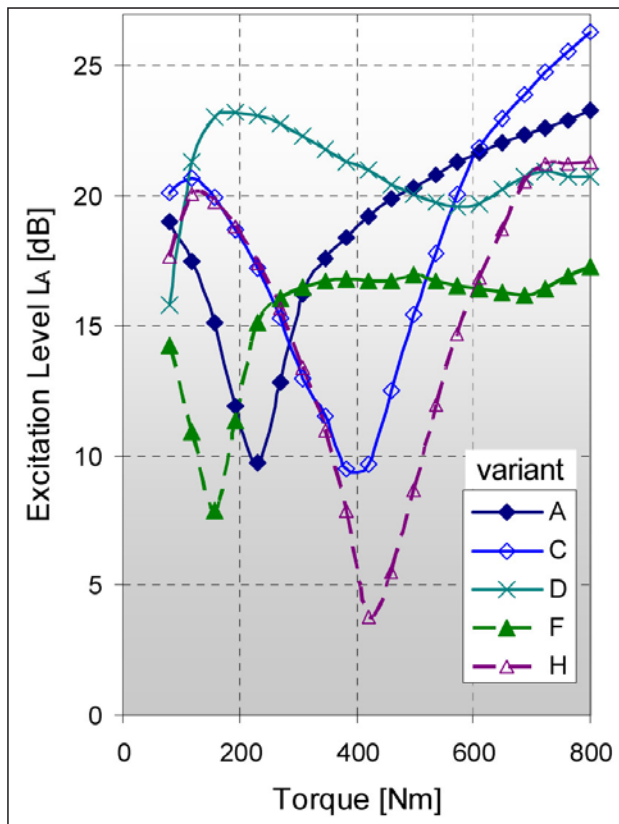


Figure 13 Excitation level  $L_A$  for different gear sets from Figure 12.

and frictional forces, and the torque loss follows from the difference compared to the nominal output torque. The lever arm of the friction-induced torque changes with the distance from the pitch point. The frictional forces are defined as a product of vertical force and coefficient of friction. The coefficient of friction changes via gear engagement as a result of changing sliding conditions and oil viscosities, whose action depend on the oil temperature in the area of tooth contact. A constant, average coefficient of friction can be used for a sufficiently precise solution because the coefficient of friction does not vary significantly. The relative torque balance loss  $V$  can be calculated for any point on the line of contact with the following equation (Ref. 2):

- $T_{V2}$  = torque loss on driven gear 2
- $a_w$  = service pressure angle
- $T_{N2}$  = nominal torque on driven gear 2
- $\beta_b$  = base helix angle
- $r_b$  = base-circle radius
- $\mu$  = coefficient of friction
- $\zeta$  = distance from pitch point

There are greater losses with an increasing helix angle because the torque-producing tangential force on the base circle grows smaller than the tooth-normal force, which produces the friction. Assuming constant values for center distance and transverse contact ratio, the losses decrease vis à vis an increasing ratio because the frictional force torque on the driven gear grows smaller — compared to the nominal torque — due to the greater base-circle radius. If the number of teeth is increased, the same effect occurs on both gears. Figure 11 shows the relative losses and their correlation with the distance from the pitch point per base-circle radius, at various ratios  $i$ , for a friction coefficient  $\mu = 0.05$  and a base helix angle  $\beta_b = 30^\circ$ . Also shown are the limits of the transverse path of contact with a transverse contact ratio  $\epsilon_\alpha = 1.5$  for  $z_1 = 12, 24$  and  $48$ . A small distance of start and end of tooth contact from pitch point is most effective for reducing power losses by means of tooth geometry. This can be achieved with reduced tooth height or increased operating pressure angle. Reduced tooth height is possible with lower tooth addendum as well as lower module with increased number of teeth. The use of lower module leads to larger overlap ratios that curb noise excitation, but root stresses increase simultaneously. The potential of reducing losses by changing tooth geometry is shown (Fig. 12); the means for reducing addendum and the option of increasing number of teeth are used, with some examples starting from variant A. The operating pressure angle was further increased at some side steps. Increasing the number of teeth is most effective in that reduced addendum and increased operating pressure angle have less influence. Traces of noise excitation level versus a load range of 10–100% of nominal load are plotted (Fig. 13). The clearly visible differences have to be considered in optimizing gears for low power loss. Improvements can be achieved with adjusted tooth modifications.

Maximum stresses for nominal load are shown (Fig. 14). Hertzian pressure is nearly constant and root stress shows a distinctive increase over decreasing loss factor from variant A



to H. Ultimately, the load distribution along the line of action is also influencing the level of power losses. Tooth loads at beginning and end of contact can be reduced by increased tip relief, which decreases their large proportion to overall power loss (Fig. 15). Means of relieving start and end of contact for increased load-carrying capacity are also helpful for minimizing power losses.

### Recent Transmission Developments

**Electromechanical power steering.** In recent years hydraulic power steering for small and mid-sized vehicles was replaced by electromechanical power steering. There are different designs, e.g. — so-called “dual-pinion” steering systems or column-type steering. In this design the servo effect is brought to the rack via a second pinion; another configuration is presented in Figure 16. The steering impulse is carried from the driver via the steering wheel to a steering pinion and steering rack. The electric motor is activated via a sensor unit that gives the steering support to a steering pinion via a crossed helical gear transmission. In contrast to all hydraulic steering systems, the electric power steering system does not use permanent energy; rather, energy is only used when it is steered. This leads to significant fuel consumption economy. Figure 17 shows measurement results with an electrical steering system for a NEDC driving cycle. This subsequently leads to fuel consumption economization of approximately 6% through use of the EPS (electric power steering), in comparison to a hydraulic steering system. The use of 10 million such steering systems would lead to reductions of approximately 9.3 million tons of CO<sub>2</sub> (Ref. 4).

**Automatic transmissions.** In order to meet the continually rising requirements in fuel consumption economization and CO<sub>2</sub> reduction, ZF decided to develop an 8-speed automatic transmission for standard drives (Ref. 5). Each new generation of transmissions has come with new goals that reap improved benefit for the customer, compared with the previous generation. The 8-speed transmission (Fig. 18) is based on a gear set system with 5 shifting elements and 4 planetary gear sets; the overall gear spread is 7.05. The harmonic transmission ratio series, the good gear set efficiency and the balanced rotational speed and torque splitting within the transmission provide conditions for compact construction and good internal efficiency.

This is supported by just two open-shift elements per gear. The design space is comparable to the 6HP28 forerunner transmission; the weight was reduced even further with a lightweight construction. A new triple-line converter is used in the transmission, with the lock-up clutch regulated by a separate line. According to (Ref. 5), various torsion damper systems are available in the building set in order to enable an optimal adjustment to the particular driveline. For consumption reasons, the lock-up clutch can be closed immediately after start-up. For the oil supply, a vane cell pump was developed parallel to the axle, lying close to the control unit and powered via a roller chain. Wheel sets and clutches are constructed with optimized design space and weight, and can be adjusted to the engine torque in various configurations. The transmission housing is one-sided because of rigidity, and

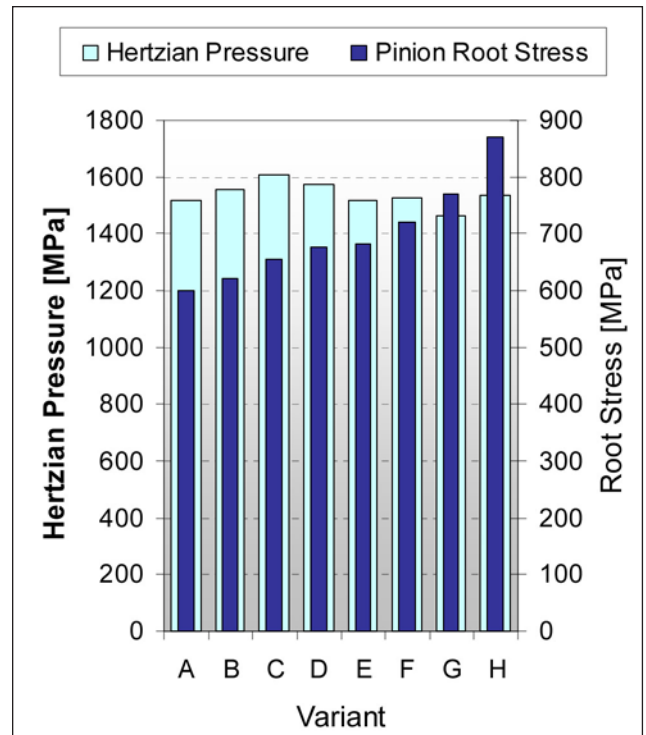


Figure 14 Calculated pinion root stresses and flank pressures for gear sets shown in Figure 12.

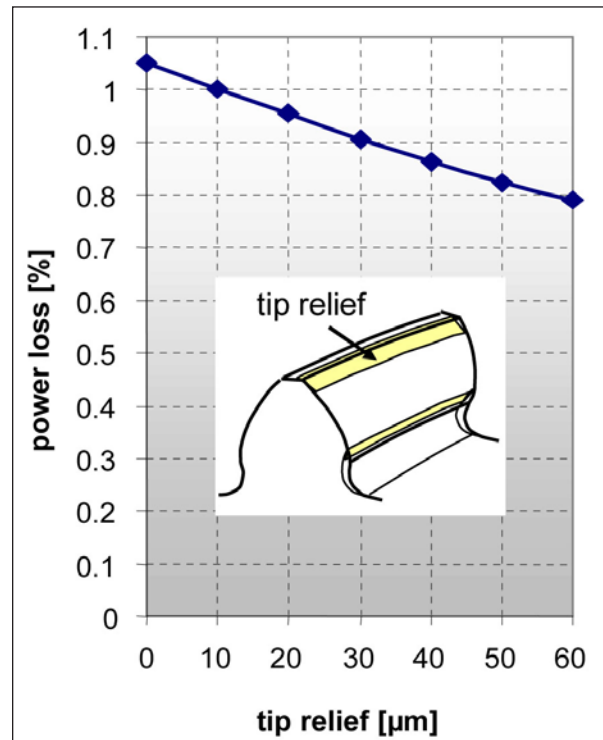


Figure 15 Influence of tip relief on gearing power loss.

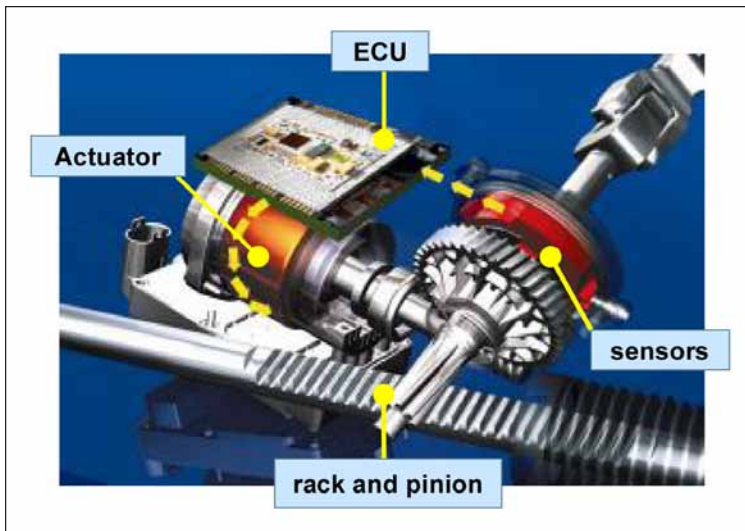


Figure 16 Electromechanical power steering assemblies as a highly complex mechatronic system (Ref. 4).

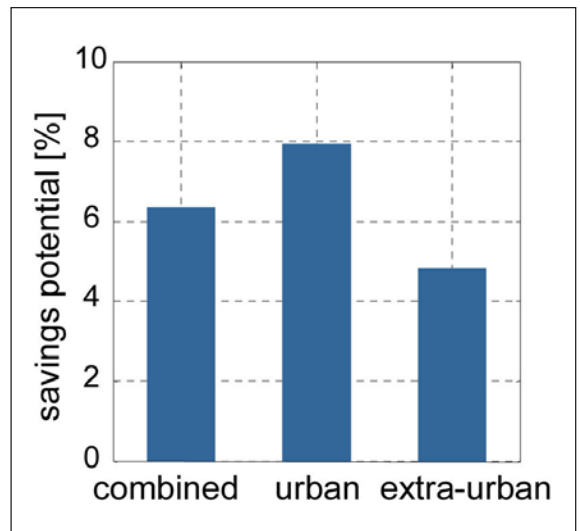


Figure 17 Conservation potential with electromechanical steering systems (NEDC, car 1,400 kg, 2 l engine).

the wall thickness was reduced locally to 3 mm. The plastic oil pan was largely carried over from the previous transmission. The parking lock is based on the proven cone/catch system; a strengthened version is available for heavy vehicles or trailing loads. In these times of increasing energy costs and requirements for lower vehicle CO<sub>2</sub> emissions, the reduction of fuel consumption was naturally one of the primary development goals. A significant value was achieved, with a contribution of 6% as compared with the second-generation 6-speed transmissions. Approximately 6% better fuel consumption results from the larger transmission-ratio spread and greater number of gears, the reduced internal drag torque, the efficiency-optimized pump and the low converter clutch rpm connections (Fig. 19).

Because of the parallel development of transmissions within the model

range, many synergies can be utilized by using similar or identical parts. The transmissions can be equipped with different starting systems and 4WD technologies. Regardless of the dimensions, micro-hybrid, mild-hybrid and hybrid systems can be integrated; the transmission is therefore well equipped — even for future drivelines. Meanwhile, there is also a start/stop function that leads to a fuel consumption reduction of approximately 5%. A hydraulic impulse accumulator provides the transmission with hydraulic oil while the engine is idle.

**Automated commercial vehicle transmissions.** Although 11% of CO<sub>2</sub> emissions in Germany come from passenger cars and only 5% from commercial vehicles, ZF sees the need and the opportunity to make appropriate contributions. These relate to, among others, reduction of transmission weight, optimal inter-

play of vehicle and transmission, intelligent driving strategy and enhanced optimization of the already extremely high transmission efficiency (approximately 99% in the direct-gear MT/AT). According to (Ref. 6), the compact and efficient automatic transmissions of the ASTronic series — with their low-torque, specific weight and intelligent driving functions that work together optimally with vehicle and engine — offer approximately 3–5% fuel savings as compared to a manual transmission. It is indeed true that a disciplined, well-trained driver can achieve good results with a manual transmission. But, on average, and in a Monday-through-Friday fleet, the automatic transmission is *always* focused and supplies continuous, good results (Fig. 20). These transmissions provide comfort that approximates that of a passenger car, and they contribute to improved road

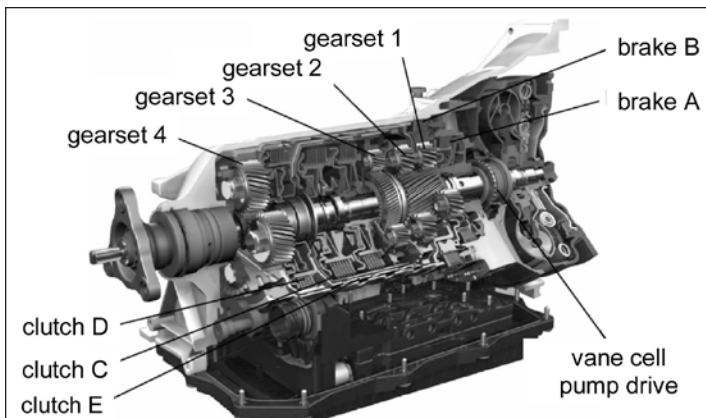


Figure 18 Transmission section 8HP70 (Ref. 5).

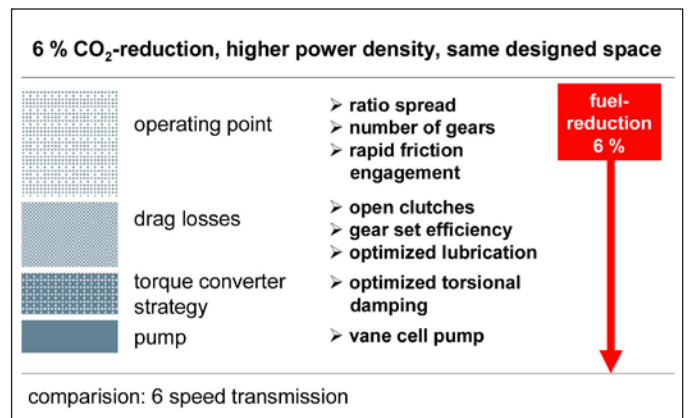


Figure 19 Measures by ZF to reduce fuel consumption in 8-speed automatic transmissions (Ref. 2).



safety. The potential for additional fuel consumption and CO<sub>2</sub> emissions savings also occurs by increasing the transmission's overall gear speed (modern transmissions for a 40-ton truck have a transmission-ratio spread of approximately 17:1 or greater). In addition to the so-called "overdrive transmissions" (ODs), ZF generally offers versions in direct-drive (DD). In long distance traffic the highest gear is used for 90% of all driving time. Having the direct-drive in the highest gear saves approximately 0.4–0.5 additional liters of fuel per 100 km. It is therefore important to have sufficient number of gears for minimizing fuel use so that the engine is always in the most fuel-efficient operating point. The truck is the pioneer in this respect, as it already has 12 to 16 gears.

**Rear-axle transmissions:**

**Standard final-drive.** In conventional drivelines with rear-wheel drive, the torque is transferred over rear-axle transmission with differential to the drive wheel. As presented (Fig. 1), the efficiency of the rear-axle transmission substantially influences the overall mechanical efficiency of the driveline. Because of noise, strength and designed space, hypoid gears are used. As a result of the percentage of relative sliding, and depending on the axle offset, these provide efficiencies of only 90–93% (Fig. 2). Influencing variables on the efficiency of a rear-axle transmission is described (Ref. 10). They include losses in seals and bearings, losses due to lubricant and gear meshing, and losses that alter the abovementioned variables as a result of operating conditions. The gear geometry parameters have the greatest influence to reduce tooth friction losses. According to (Ref. 10) a small-module gear invariably possesses greater efficiency, owing to its high contact ratio, lower curvature and lower profile height. Conventional rear-axle transmissions for passenger cars used to be designed with tapered roller bearings and partial cast-iron housings. Now, through use of low-friction, angular ball bearings; optimized lubricants and oil levels; aluminum housings; and welded crown wheels; weight can be reduced by 7 kg and fuel consumption by 1–1.5% (Fig. 21).

**Vector-drive, rear-axle transmission.** Through demand-controlled active distribution of the drive torque to the four

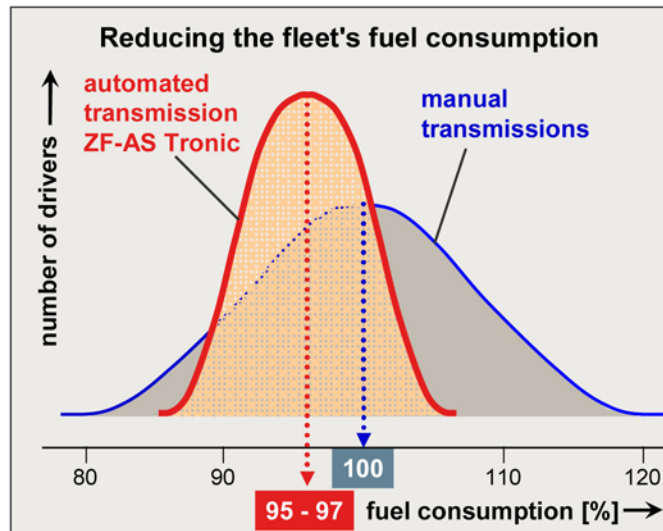


Figure 20 Reduced consumption using automatic transmissions (Ref. 3).

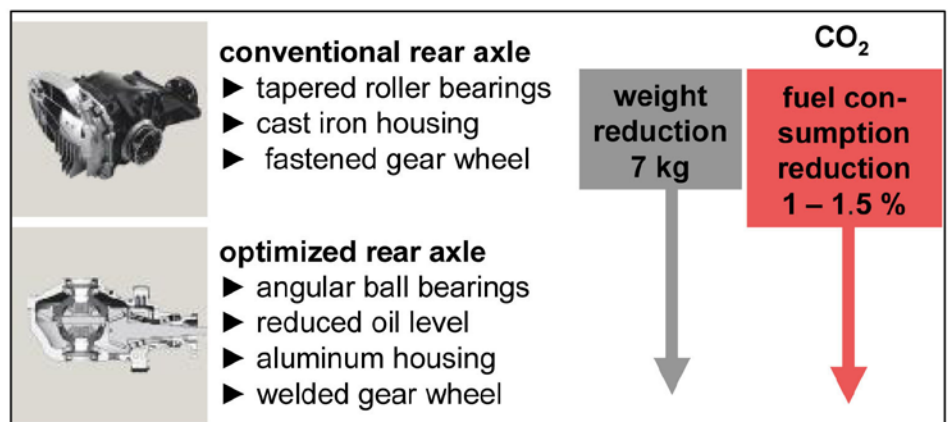
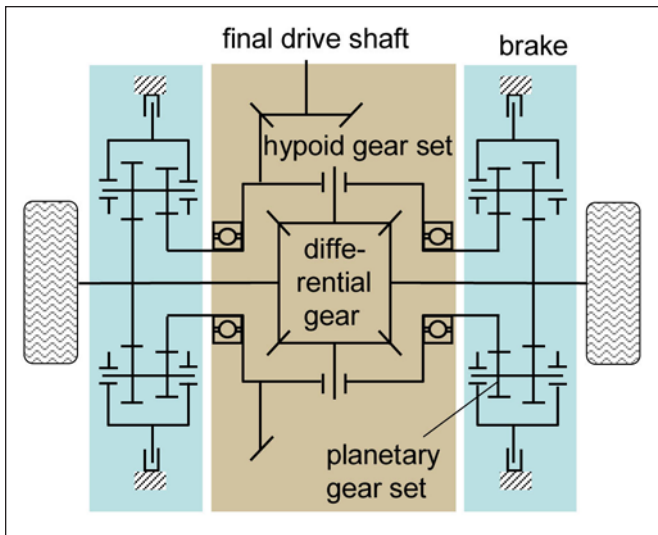


Figure 21 Possibilities for CO<sub>2</sub> reduction with rear-axle transmissions (Ref. 2).

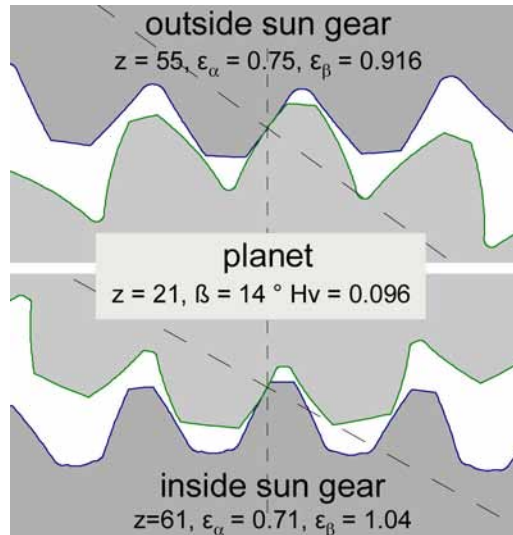
wheels, vehicle agility—and driving safety—are improved. Additional dynamic driving potential is also possible if the degree-of-freedom of transverse torque distribution is utilized. A torque-vectoring system can relieve the inside wheel of torque and feed more torque to the outside wheel. This is advantageous for two reasons: 1) on one hand, a yaw moment acts on the vehicle, supports cornering and thus increases agility; 2) on the other, the potential of grip utilization of both wheels is better utilized. Power reserve is increased on both sides, as is safety (Ref. 15). The selected principle is based on a planetary drive with two center gears, as well as two-stage planet gears (Fig. 22). The inner-center gears are rigidly coupled to the differential cage, while the outer sun gears are connected to the respective output shafts. With the axial force impact from the disk package—which, in this case, positively engages the housing and the planet carrier to one another—

a braking torque can be applied to the planet carrier. This causes a torque flow that transfers torque from the differential cage to the output shaft through acceleration of the outside sun gear, as enabled by the selected ratio in the planetary gear. In contrast to the open differential, the two outputs are powered at different torque value levels. A torque-vectoring moment or wheel differential torque takes effect, resulting in the desired yaw moment in vehicle motion. Compared to the drag power of a standard, rear-axle drive with open differential, the additional loss caused by the torque-vectoring units is comparatively low.

The ratio between the wheel differential torque and the brake torque acting on the planet carrier is referred to below as the "amplification factor." In the present application of a planetary drive it is necessary to consider that the effective amplification factor depends on both the stationary efficiency of the plane-



**Figure 22** Functional diagram of planetary-based torque-vectoring transmission.



**Figure 23** Section of low-loss gears in planetary drive of torque-vectoring transmission.

tary drive as well as the speed ratios of the two center gears. For this reason a distinction must be made between the curve-supporting use (veering in), and the stabilizing intervention (veering out). A stationary transmission efficiency of the highest-possible level is most desired in order to keep the difference in amplification factor between veering-in and veering-out as low as possible. To reduce the power loss of the planetary drive, it was decided to design the gears as so-called “low-loss-gears” with a reduced contact ratio (Fig. 23). The contact ratio in both gear contacts is lower than one and therefore a helical gear set with a certain amount of overlap ratio is necessary. The calculated gear loss factor  $H_v = 0.096$  is rather low.

### Summary and Outlook

- CO<sub>2</sub> reduction is an essential technology driver for driveline and transmission development in modern motor vehicles.
- This was demonstrated by recent real-world examples that have already achieved success and are incorporated in volume production.
- In order to reduce churning losses, lubricants with increasingly lower viscosities are used. The limits of service life should be noted.
- For investigating the influence of lubricant in gear mesh, a lubricant efficiency test was developed. Standard C-type gears as well as actual transmission gears can be used.
- On the basis of the LVR program, a gear efficiency calculation module was developed that considers gear load-sharing distribution and gear modifica-

tions. Tip relief has a positive influence on gear efficiency.

- Internal gear sets deter power loss, compared to externals.
- Electromechanical steering systems lead to reduction in fuel consumption of approximately 6%.
- Eight-speed automatic transmissions of the newest transmission generation boast a reduction in fuel consumption of approximately 6% compared to 6-speed transmissions.
- Transmissions with a start/stop function reduce fuel consumption by approximately 5%.
- Automatic transmissions reduce driver influence on commercial vehicles and thus reduce fleet fuel consumption by 3–5%.
- With rear-axle transmissions, a reduction in fuel consumption up to 1.5% can be achieved by using special bearings, optimized oil levels and weight reduction.
- The optimization of *all* components in the transmission — with regard to optimal integration — offers potential improvement of up to 30% (Ref. 2).
- A first step has been taken toward further development in the reduction of friction losses through the creation of optimized coatings and lubricants. ⚙️

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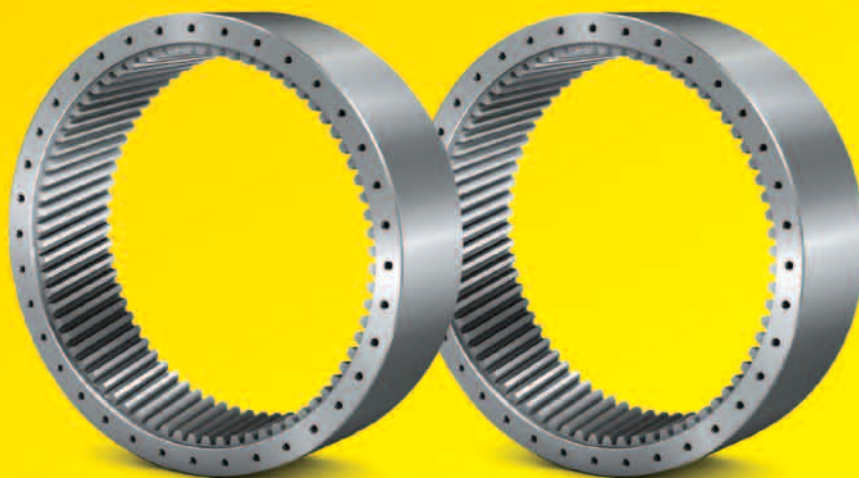
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**Dr.-Ing. Franz J. Joachim** is director of gear development, **Dr.-Ing. Norbert Kurz**, manager of the Gear Laboratory and **Dr.-Ing. Joer Börner**, manager/calculation gear tools—all for ZF Friedrichshafen AG, Germany.



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## DMG/MORI SEIKI UNIVERSITY CHART COURSE FOR MANUFACTURING EDUCATION AND TRAINING

They sit attentively in packed classrooms, hang on every PowerPoint slide, and clamor for more. It's not behavior typical of on-the-job trainees — but it's an exciting reality for DMG/Mori Seiki University (DMSU) instructors who have their sights set on upper-echelon workforce development. While originally intended for customer-oriented machine training, the DMSU curriculum has grown into an engine for internal transition. "When DMG and Mori Seiki joined forces in the United States in April 2010, people both inside and outside of the organization were skeptical that it would be successful," says Rod Jones, chief learning officer at DMSU. "DMSU has played a key role in bringing about organizational change in this regard."

During the 2010 fiscal year, DMSU experienced staggering growth of 140 percent. Since the DMG/Mori Seiki partnership announcement, classroom instructors and online courses have delivered more than 108,000 hours of training, 72 percent of which were employee- and distributor-focused.

"Before, we had to beg our people to attend these classes," Jones says. "Now, it's a total reversal; we can barely keep up with the requests to attend because the distributors and engineers see the value."



**DMG/Mori Seiki understands the value of educating its own workforce as well as its customer base.**

This metamorphosis hasn't come at the expense of customers — quite the contrary. As Jones explains, an organization can't put 78,000 hours and significant monetary investment toward internal training without effecting positive change.

"It's the iceberg effect: You only see the tip of DMSU benefits: i.e., direct customer training," he says. "The indirect benefit is the fact that the DMG/Mori Seiki USA distributors and the engineers who serve them are now a much stronger, more confident, more powerful force than ever before, thanks to the training they have received."

Getting employees and distributors up to speed on hundreds of new machine models and technologies was no simple feat.



**Originally intended for customer training, DMSU has also developed into a successful internal training program (all photos courtesy of DMG/Mori Seiki USA).**

Jones and his team went above and beyond — investing heavily to bring teams of instructors from Germany to teach nearly three dozen new, unique DMG-specific classes.

Internal parties also take machine-specific courses that cover programming, operation and maintenance through DMSU's Education on Demand, the University's online platform.

"During the time that we were focusing on internal education, we never denied training to a single customer; in fact, that side of the University continued to expand as well," Jones says. "But we really turned DMSU upside down to help support the business goals and the success of the DMG/Mori Seiki USA collaboration."

Jones doesn't see any letup in the intensity of internal training. His team is facilitating an apprenticeship program that sends students to Germany for as long as two years to learn factory processes, take classes led by DMG engineers and bring their knowledge back to the United States. A similar scenario is occurring within the new Mori Seiki manufacturing plant in Davis, California. There, recruiters are working directly with Japanese factory personnel to give new hires the most in-depth education possible. "We have to home-grow our people — they just aren't out there," Jones says.

Jones acknowledges the huge difference in the way DMG/Mori Seiki USA approaches internal training, as compared to other machine tool makers. "I know from my previous work as a consultant that most people in the manufacturing industry see training as a necessary evil," he says. "One of the reasons I closed my business and came to DMG/Mori Seiki USA is because the organization understands the value of educating its people."

Anyone can give a lecture in front of a classroom — but it takes experience, critical thinking and some serious elbow grease to develop a worthwhile course from scratch. And that's just what DMG/Mori Seiki USA instructors do every day.

When new machines or technologies arise, engineers and DMSU staff travel to DMG and Mori Seiki factories around the globe to learn from local employees, perform programming





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**Rod Jones, chief learning officer at DMSU, is proud of the work the company has achieved in manufacturing training and development.**

operations and service procedures, and document the process. From there, instructors painstakingly write, design and develop every last detail of online and classroom courses — from virtual machining demos to proficiency-based test questions.

The task of developing machine-installation protocol is perhaps even more arduous — but the resulting training courses solve problems that have dogged an entire industry for decades.

“Before coming to DMG/Mori Seiki USA, I consulted more than 100 manufacturing clients — and instituting authorized installation processes was a challenge for them all,” Jones says. “In this industry, it’s standard protocol to throw a brand new machine out in the field with service guys who have never had a day of training on it. It’s always been a struggle for the machine builder to control the process.”

One such struggle was the installation of the large and complex NT6600 DCG. To alleviate the costs, pain and troubleshooting associated with inconsistent installation of this and other complex machines, DMSU employees track and document approved installations and develop repeatable, step-by-step processes and certification courses for U.S. service engineers.

“Before, we were bringing in full teams from Japan to ensure proper protocol, which could take weeks and weeks,” Jones says. “Now, the customer gets a factory-authorized installation from their local service technician.”

Since beginning this initiative, customer complaints relating to NT and other complex machine installations have virtually vanished. It’s not the only area in which a committed focus to internal training has gone a long way to boost customer perceptions and satisfaction.

“I just saw the results of our annual customer survey, and the perception of our training and service has visibly improved,” says Jones. “I’d like to think that, whether customers realize it or not, our team had something to do with it.”

For more information, visit [www.dmgmsuondemand.com](http://www.dmgmsuondemand.com).



# Morrisson

## JOINS SOUTH BEND GEAR

Paul Morrison has joined South Bend Gear, LLC as operations manager of the recently built manufacturing plant that produces gears for heavy-duty truck engines. Morrison will be responsible for overseeing production at the new facility on the Schafer Gear campus. South Bend Gear is a joint venture of Schafer Gear Works and Somaschini S.p.A. of Italy. Prior to joining South Bend Gear, Morrison was vice president of manufacturing at Flexco Products Group in Elkhart, Indiana. He previously served as plant manager of a steel storage systems facility and has also held quality control and manufacturing management positions. Morrison has a bachelor of arts in business administration from Western Michigan University and Six Sigma Black Belt and Lean Manufacturing Certification. "We are very pleased to have Paul as operations manager of the joint venture facility," said Bipin Doshi, president of Schafer Gear. "Paul's extensive experience in quality assurance and management of complex manufacturing facilities is very valuable and will allow us to smoothly double the production capacity of South Bend Gear by the end of this year."



# Gleason

## OPENS NEW CHINA FACILITY

Gleason Corporation recently announced the grand opening and dedication of a new world-class manufacturing facility in Suzhou Industrial Park, Jiangsu Province, China. The new facility is home to the company's Gleason Gear Technology (Suzhou), Co., Ltd. (GGTS) operation, which was established in 2007. The new factory brings together under one roof the company's machine and cutting tool production, which were formerly located in separate facilities in the Suzhou Industrial Park. The new factory is a LEEDS-qualified 14,500-



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square-meter (156,000 sq. ft.) facility, climate-controlled for high-precision manufacturing. GGTS produces Gleason's line of Genesis gear hobbing machines for the China market, and also produces a large line of gear cutting tools including hobs, shaper cutters and bevel gear cutting tools. Gleason expects additional products and services will be added over time as market needs and opportunities present themselves. "We are proud and excited to open this state-of-the-art facility expanding our already growing presence in China," said John J. Perrotti, president and CEO of Gleason Corporation. "This investment in our new facility along with the continued expansion of our technical staff in China is a strong statement about our long-term commitment to this important market."

## Cleveland Gear CELEBRATES 100 YEARS

Cleveland Gear Co., a pioneering force behind worm gear manufacturing in the United States, is celebrating 100 years of continuous manufacturing of gearing technologies. "Few companies get to experience a 'Centennial Celebration' with the same name and in the same location, as the average life expectancy of the typical large American enterprise is less than 50 years," says Dana Lynch, president, Cleveland Gear. "When you think, in the last decade alone, of the long list of big corporate failures, it makes you proud that Cleveland Gear is enjoying record sales and prosperity, celebrating its 100th year of operation."

Cleveland Gear was founded in 1912 as Cleveland Worm & Gear by F.M. Gregg, C.J. Fitzpatrick and David Fitzpatrick, the latter bringing his knowledge of worm gear design and production technology to the United States from his native England. In the first year of operation Cleveland Worm & Gear produced 2,000 sets of gears with 20 employees. In just six years, the company reportedly employed 300 individuals and produced 80,000 worm gear sets for automotive applications. It also introduced the first standard worm gear speed reducers, earning recognition by the AGMA, which established their design as the industry standard. In 1920, David Fitzpatrick received U.S. patents for material design concepts and production tooling and machinery that remain relevant today.

The company continues to be the innovator of many worm gearing and enclosed drive designs. Throughout its history, these innovations have included the first worm gear speed reducer designed specifically to handle high over-hung loads; the first box-type housing, which increased heat dissipation during operation; the CU unit, designed specifically for driving induced-draft cooling tower fans; the Speedaire line of fan-cooled worm gear speed reducers that set a new standard of worm gear performance by increasing the unit's thermal horsepower capacity while reducing its overall size; the Cleveland M series Modular speed reducers, expanding Cleveland's product range down to 1.33" CD; and the introduction of Cleveland Custom Parallel Shaft Reducers.

Cleveland has been recognized for its involvement with the U.S. Military. In 1943, 1944 and 1945, Cleveland Worm & Gear was awarded the Army-Navy "E" Award for distinguished service to the World War II war effort for supplying worm gearing

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and worm gear drives for ships, airplanes and other war-related vehicles and machinery. In 2006, Cleveland Gear employees were called upon to supply a custom gear for the U.S. Navy's USS Essex (LHD 2), based in Yokosuka, Japan. They machined and shipped the gear to Japan in less than 72 hours.

Cleveland Gear continued manufacturing its product offerings at the E. 80<sup>th</sup> Street plant through two acquisitions. In 1959, Cleveland Worm & Gear was acquired by Eaton Axle & Spring (later called Eaton Yale & Towne and, today, Eaton Corp.). The company was then known as the Industrial Drives Division of Eaton Axle & Spring until its acquisition in 1980 by Vesper Corporation of Brecksville, Ohio, now called The Industrial Manufacturing Company.

Cleveland Gear Co., celebrating 100 years of operation, manufactures worm gearing, speed reducers, standard and custom drives and speed variators for a variety of industries, including construction equipment, steel production and processing, and oil and gas exploration and production. Boasting an inventory of more than 10,000 hobs and master worms, the company is capable of accurately duplicating virtually every worm and gear manufactured by Cleveland Gear over the past 100 years. For more information, visit [www.clevelandgear.com](http://www.clevelandgear.com).

## Mike Chester

### WINS 2012 WINZELER AWARD

Winzeler Gear, in coordination with the Tooling and Manufacturing Association (TMA), has named IMS Companies vice chairman Mike Chester winner of the 2012 Winzeler Award. Winzeler Gear president John Winzeler presented the honor to Chester during TMA's 86th Annual Meeting. Created in 1971, the annual award recognizes individuals for their outstanding service to the tool and die industry. For the past 20 years, it has been sponsored by Winzeler Gear. Previous winners include Fred Buhrcke, the founder of Buhrcke Industries (now known as IMS Buhrcke-Olson), who hired Chester as a die maker in 1986 and served as his mentor. "To be on the same



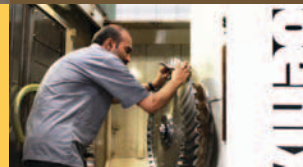
John Winzeler (left) presented Mike Chester (right) with the 2012 Winzeler Award during TMA's Annual Meeting.

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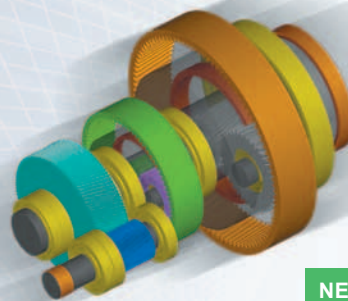
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roster as Mr. Buhrcke and other industry leaders is an honor that I'll treasure forever," said Chester.

"Mike's achievements over his 35-year career, combined with his support of TMA, were key reasons for his selection," said Winzeler during the award presentation. Many of these achievements were made by Chester as he rose through the ranks at Buhrcke, where he initiated the company's first strategic plan and helped champion QS 9000 and TS 16949 certifications. He and a partner later purchased the company in 2001. As the company's leader, Chester implemented restructuring measures and strategic growth initiatives that led to Buhrcke's 2004 acquisition by IMS Companies. While managing Buhrcke, Chester remained an avid supporter of TMA, serving on its board and leading the organization as its chairman in 2004-2005. He currently serves on TMA's Manufacturing Education and Careers Committee.

## Cameron SELECTS BRAD FOOTE TO SUPPLY GEARING

Cameron has selected Brad Foote Gear Works, Inc., a subsidiary of Broadwind Energy, to supply enclosed drives and open gearing for use on off-shore oil platforms. Shipments to Cameron are expected to begin in fourth-quarter 2012 and continue into 2013. "Brad Foote's impressive commitment to continuous improvement and deep expertise in precision gearing fits closely with Cameron's commitment to product excellence. We look forward to working with the Brad Foote team," said Bill Haggard, supply chain manager for Cameron's drilling systems division. Since 1924, Brad Foote Gearing has produced tight-tolerance gearing for markets as diverse as oil and natural gas, mining, steel, transportation, power generation and wind. The company is a founding member of the American Gear Manufacturers Association and was honored for becoming the first U.S.-based gear manufacturer to be ISO 9001-certified. "We are delighted to help meet Cameron's need for enclosed drive and open gearing," said Daniel E. Schueller, president of Brad Foote Gear Works, Inc. "This win is another success in our ongoing diversification into a variety of energy and infrastructure markets." For more information, visit [www.bwen.com](http://www.bwen.com).

## Bagley JOINS MAZAK CORPORATION

To meet the demands of its rapidly expanding market in the American Northeast, Mazak Corporation has hired a new account manager, Andrew Bagley, a seasoned mechanical engineer and machine tool expert. In his new position, Bagley will manage and direct the sales of Mazak's full suite of machine tools, from productivity-improving multi-tasking solutions to automated manufacturing systems for Done-in-One unattended part production, in Maine, New Hampshire and Vermont. In support of the com-





pany's ongoing commitment to customer education and support, Bagley will also provide after-sale technical support and provide educational presentations about the technical features of Mazak machines. Bagley has extensive machine tool experience, having previously worked as a service engineer and metrologist, and has been recognized for the development of lean manufacturing processes and educational and training efforts for several leading manufacturers. "Andrew has excellent experience in the industry and has proven to be a true team leader when it comes to customer service, training and support," said Steve Wilkins, regional manager of the Northeast region for Mazak. "We're excited to have him as a member of our team and another resource for our valued customers." Bagley attended the University of New Haven where he studied mechanical engineering and has advanced in the field, from a machine technician and designer to service engineer responsible for company-wide training and installation, repairs, customer support and part programming for ultra-precision equipment.

## American Wera

### RENAMED GERMAN MACHINE TOOLS OF AMERICA

American Wera is now officially renamed German Machine Tools Of America (GMTA) and continues to represent various top-quality German metalworking machine builders, including Profilor, Pittler, Praewema, WMZ and MAE. These machines are sold for gear and spline production, vertical turning, flexible machining solutions (blank to finish part solutions), as well as bar, pipe and tube straightening plus wheelset pressing. The company's target markets include automotive, off-highway, OCTG, rail, wind energy and other heavy equipment



manufacturing. This announcement was made jointly by GMTA President Walter Friedrich and Vice President of Sales Scott Knoy. "The reason for the name change is simply that the parent company wished to use a name that is more representative of all the lines we handle in North America," said Knoy. Originally formed as the North American subsidiary for Wera in Germany, GMTA today provides application engineering, sales and service for a broad range of machine tools and metal fabricating equipment. GMTA has representatives throughout the U.S., Canada and Mexico. Other key company individuals include Claudia Hambleton, treasurer; Doug VanDeven, service/parts manager and Shawn Wilkin, senior service engineer. Joseph Kemple remains the dedicated product manager for the MAE line of straightening and wheelset presses.

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### September 18–20 – SAE 2012 Aerospace Manufacturing and Automated Fastening Conference and Exhibition.

Fort Worth Convention Center, Fort Worth, Texas. The exhibition will provide a forum for the aerospace community to present and discuss current and future challenges, opportunities, and requirements of next-generation aircraft R&D, products, and systems. Technical sessions, lively panel discussions and keynote presentations will be the highlight of this event that is essential for engineers, scientists, designers, program managers and operators in industry as well as government and research facilities. Topics include: automated fastening/assembly and tooling, composites materials and processing, information technology, lean manufacturing and supply chain management, ferrous/nonferrous metals and processing, structures, automated manufacturing and sustainability. For more information, visit [www.sae.org](http://www.sae.org).

### October 7–11 – Materials Science & Technology Conference & Exhibition.

Pittsburgh, Pennsylvania. MS&T brings together professionals from virtually every field of materials science: metals, polymers, ceramics and composites. Attendees will have the opportunity to reach potential customers in industries like automotive, aerospace, instrumentation, medical, oilfield and energy. The MS&T partnership of four leading materials societies – ACerS, AIST, ASM and TMS – brings together scientists, engineers, students, policy makers, suppliers and more to discuss current research and technical applications, and to shape the future of materials science and technology. Since corrosion remains a relevant topic to materials, NACE International will again co-sponsor MS&T. Areas of interest include biomaterials, iron and steel, ceramics, materials performance, nanotechnology and processing and product manufacturing. For more information, visit [www.matscitech.org](http://www.matscitech.org).

**October 15–19 – AME Chicago 2012.** Sheraton Chicago Hotel and Towers. The Association for Manufacturing Excellence (AME) has a long track record for finding and convincing some of the best manufacturing practitioners from around the world to share their lean practice experiences. More than 60 leading presenters will be on hand to discuss customer focus, process sustainment, continuous improvement, material flow and other lean practices and strategies. Manufacturing tours highlighting some of the best lean and six sigma operations in and around the Chicago area include Caterpillar, Bimba Manufacturing, Whiting Corporation, S&C Electric Company and Winzeler Gear. Workshop topics include maintenance management, lean behaviors, training within industry, lean business simulation and lean tools for the office. Six keynote speakers will be featured at the conference including Mike Abrashoff and Jason Jennings. For registration information, visit [www.ameconference.org](http://www.ameconference.org).

**October 22–24 – 3rd Annual American Manufacturing Strategies Summit 2012.** McCormick Place, Chicago. The Manufacturers Alliance/MAPI Survey on the Business Outlook shows ongoing expansion of manufacturing in the United States, although the speed of growth could be slowing. As the American economy continues to recover, it is critical that manufacturers adopt new processes to enable more effective production and order fulfillment. Researched and validated by senior industry advisory board, AMS 2012 will provide leading case

studies, stimulating debate on the future of manufacturing, and valuable networking opportunities for you to share information and find future business partners. Event features include stream sessions, case studies, pre-scheduled one-to-one meetings, discussion tables, workshops and networking opportunities. Topics include reshoring initiatives, retaining the skilled workforce, optimizing the global footprint of worldwide operations, improving performance, productivity, and profitability through operational excellence and lean programming, developing the leadership tools that drive success in new programs and seeking innovations in tools, tactics and technologies. For more information, visit [www.manufacturing-summit.com](http://www.manufacturing-summit.com).

### October 28–30 – AGMA Fall Technical Meeting.

Hyatt Regency Dearborn, Dearborn, Michigan. The FTM highlights the latest research in the industry from experts all over the world on topics including micropitting, gearbox design, materials and manufacturing. The conference is designed for attendees to listen to all the presentations and take home practical information that may ultimately affect your company's bottom line. In addition, the meeting provides invaluable networking opportunities between sessions and in the evenings to interact with colleagues and meet new experts in the industry. Programs, as well as peer-reviewed technical papers, address lubrication and components, gear drive applications, manufacturing and inspection, gear design issues and materials and heat treatment. For more information, visit [www.agma.org](http://www.agma.org).

### November 13–15 – Methods, Practices, Application and Interpretation for the Design Engineer.

Hard Rock Hotel and Casino, Las Vegas. Raymond Drago, chief engineer–gear technologist, Drive Systems Technology, Inc., will instruct attendees on the methods used to manufacture and inspect gears, including external and internal spur, single and double-helical gears, as well as bevel and worm gears. A description of each basic manufacturing and inspection method is provided. Both the methodology and underlying theory are explained. The seminar also covers the methods of specifying the data required to control both the manufacturing and inspection processes on an engineering drawing and in a specification. This includes the data to be defined and its presentation on the engineering drawing. It is critical that the design engineer understand the manufacturing and inspection processes that will be employed so that the intent of the design can be successfully translated into practice. Most gear inspection centers on gear tooth geometry; however, various nondestructive and destructive tests (such as ultrasonic, magnetic particle, acid etch, etc.) are also required to ensure the quality of the basic gear material and the results of various heat treatment procedures. In this seminar the basics of a variety of these tests will be covered, including their underlying theory, application techniques and, most importantly, interpretation of the resultant data. This seminar aims to narrow and possibly close the information gap by providing gear design engineers with a good foundation in both manufacturing and inspections processes and procedures. For more information, visit [www.agma.org](http://www.agma.org).



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# Keeping Time Hawaiian-Style

**According to the site for the 2013 International Kinetic Art Exhibition and Symposium** (*intlkineticartevent.org*), “Kinetic artists seek to propel the mind to wonder and to encourage viewers to appreciate the joy in motion and learn about other ways it can benefit society.”

That is a spot-on characterization of Clayton Boyer, kinetic artist (and retired 30-year chiropractor) based in Hawaii who crafts wooden clocks—he refers to them as “mechanisms”—and makes the design plans available to all comers with a predilection for things in motion—from like-minded hobbyists to NASA employees.

Kinetic art—art that is movement-centric—evolved from the Dadaist and Constructivist movements of the early 20th century. Today, kineticists (OK—not a real word) reason that kinetics is in harmony with 21st century engineering feats such as the wind turbine, an energy source that, when converted, produces precious electricity and power.

But Clayton lays no claim to re-invention. “For the kind of mechanisms that I make, most of the gear-form ‘expertise’ has already been worked out by previous, ‘old-time’ clock-makers,” he allows. “Clocks of the 17th, 18th and 19th centuries had an importance equivalent to what computers have today. During those periods (big-brain thinkers) were dedicated to creating better and more accurate clocks; accuracy was key.”

But for Clayton and his fellow enthusiasts, the meat is in the movement—not the accuracy. It’s all about the sheer wonder and awe of motion for its own sake. “Being released from this strong tie with accuracy, as clock hobbyists we can now enjoy clock making as kinetic art, art that has accuracy as only a secondary consideration. Of course I’ve studied the various types of tooth forms, pressure angles, pitch diameters, etc. But once you’ve seen a fully functional, 300-year-old wooden clock whose teeth are triangular in shape and hacked from a wooden disc with a hand saw, it puts things into perspective. Pretty much most of that theory is allowed to flow right out the window. ‘Efficacy is the measure of truth,’” quoth Clayton, citing Serge Kahili King, a mystic of sorts and adherent of “huna”—the Polynesian philosophy of effective living, and “aloha”—the uniquely Hawaiian attitude of love and peace. In other words, says Clayton, “If it works—it’s the truth. And these mechanisms are truly forgiving.”

Clayton, a child of the 1950s and self-professed “gear head” since the age of 10, says his fascination and fervor for clock making grew out of a dream deferred; it happens that a “DIY” magazine of the time featured an article on how to build a wooden clock. “I didn’t have the money, time or tools




Boyer calls this mechanism Nautilus.

to build that clock, but I held onto that wonderful idea for the next 40 years,” he says. “I have always loved repairing old clocks, and did that as a hobby for many years. Once I retired from my practice, I returned to the idea of making my own wooden clocks. I ordered a wooden clock plan, and as soon as it arrived I dove right in. In a couple of days I had created my first wooden clock! (But then) I stood back to admire my work and thought to myself, ‘Blind monkeys could design a better looking clock than that.’”

He’s been at it ever since.

“I have always loved the idea of being able to make things move, whether with springs, weights or motors,” Clayton relates. “Wooden gears give a flexibility of design that is within reach of most home hobbyists.” And lest there be any question, “I love gears,” he says. “I love calculating ratios and seeing how new and different combinations interface with the project at hand. I think that everyone with an interest in this hobby shares a love of gears.

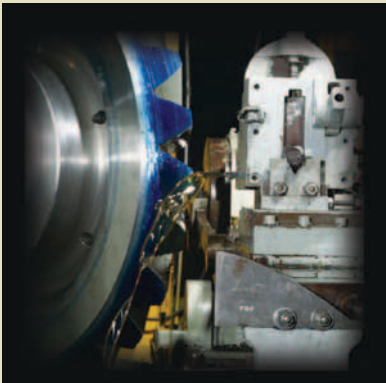
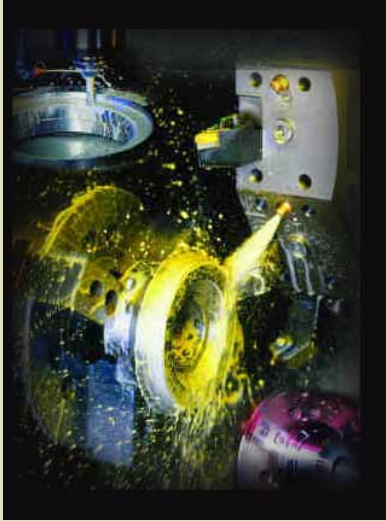
“My original purpose in making my designs available to other woodworkers was to spread the joy that I have found in creating these wonderful mechanisms. Some wooden movements that are 300 years old are still in working order today. With some care and maintenance, these clocks should outlast us and our children. Hopefully, our clocks will be passed down through the family as heirlooms.

“To come out into your shop the next morning and hear a chunk of wood that you put into motion yesterday still singing her beautiful song is truly a thrill. And even after building well over 50 of these mechanisms, I still feel that thrill with each new creation.” (To view Clayton’s “mechanisms” and for more information, please go to [www.claytonboyer.net](http://www.claytonboyer.net).) 



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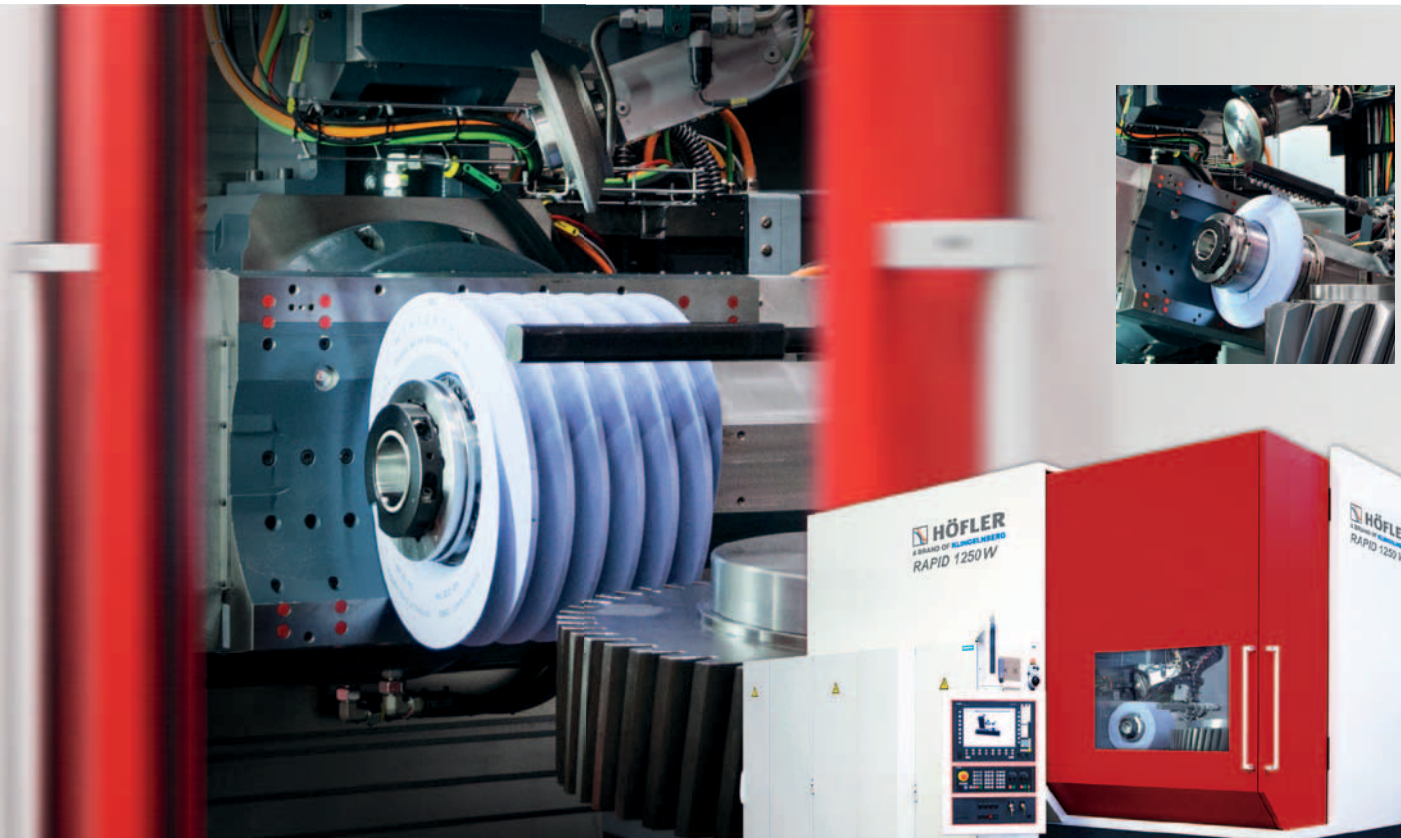
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