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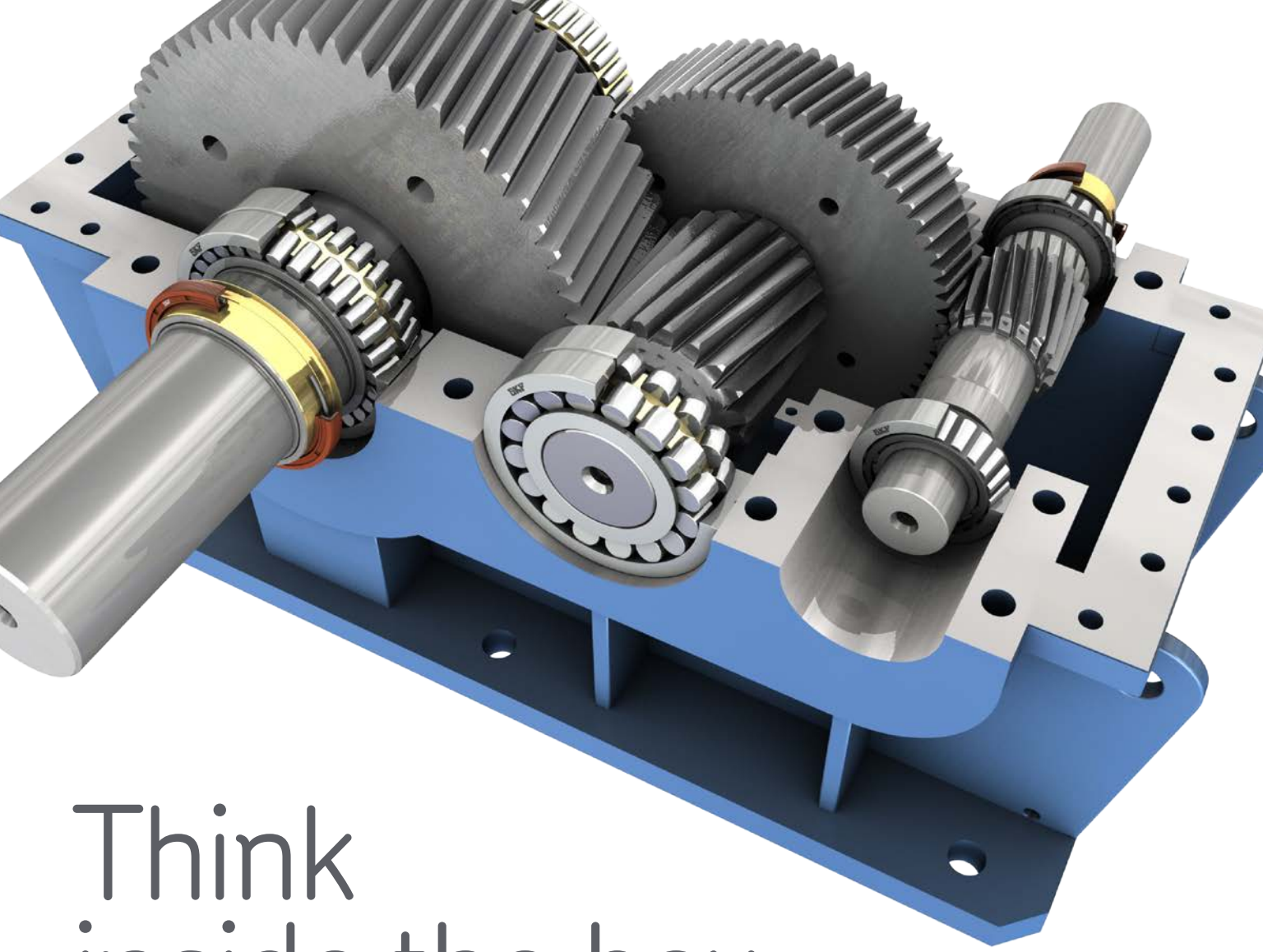

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IMTS 2016 ISSUE

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TECHNICAL ARTICLES

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Power Transmission Engineering

VOL. 10, NO. 5

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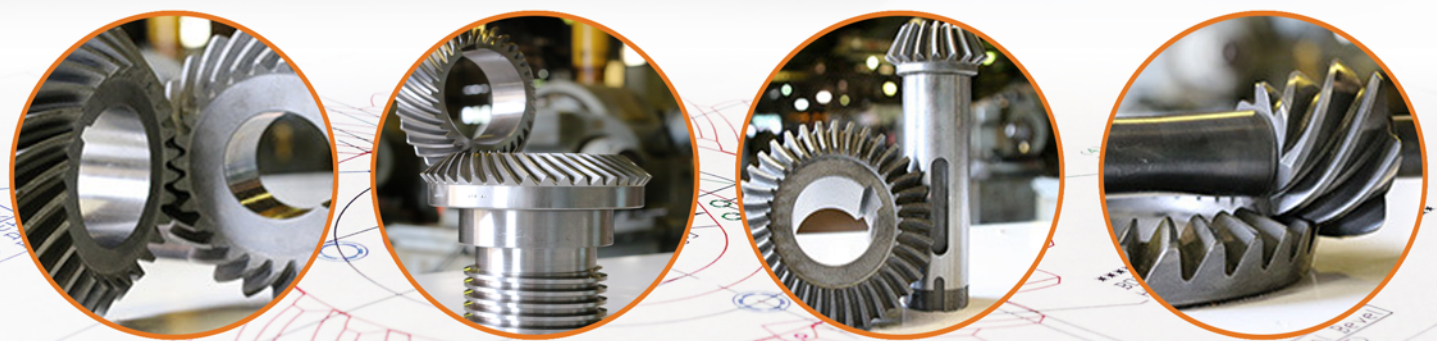

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Motor Matters with George Holling

Holling discusses the conservative nature of the motion industry and the struggle to embrace new ideas and technical solutions in his recent blog entry, "Are We Open to Change?" Read more at *http://powertransmission.com/blog/are-we-open-to-change/*.

MDA and IANA Coverage from IMTS 2016

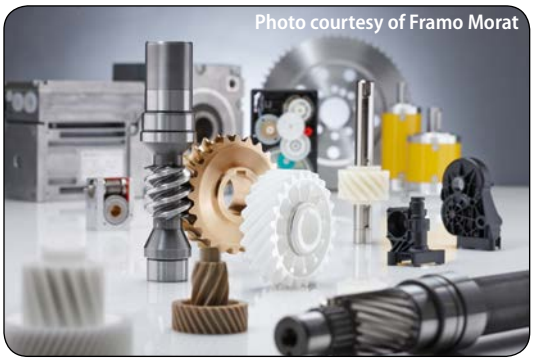
Photo courtesy of Framo Morat

Our show coverage from IMTS and co-located shows like Motion, Drive and Automation and Industrial Automation North America, will be available both in print and online. Keep coming back to the website for booth previews, show coverage, interviews with show personnel and IMTS e-newsletters (*www.powertransmission.com*).

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Do you have a question about gears, bearings, motors, clutches, couplings or other mechanical power transmission or motion control components? Submit your question and we will forward it to our panel of experts (*http://www.powertransmission.com/asktheexpert.php*).

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Randy Stott, Managing Editor

Energized

The theme of this issue is "Energy."

Energy is the worldwide addiction of the human race. We can't live without it, and no matter how much we try to conserve it, our appetite is insatiable.

Traditionally, we've dug the energy out of the ground, and this has required lots and lots of mechanical equipment, which uses billions of dollars in bearings, gearboxes, clutches, couplings and related devices.

Over the years, that's been really great for those of you who are involved in designing and maintaining that equipment. Of course, it's not so great when the price of oil and natural gas stays too low to justify exploration, extraction and production—when digging energy out of the ground isn't as profitable as it used to be.

Fortunately, there are other ways for us to get our fix. And renewables are definitely growing. This issue we've taken a closer look at the windpower industry, which is booming again, thanks in part to a multi-year extension of the wind energy production tax credit (PTC), which was enacted in December 2015. This allows the builders of wind farms to plan far enough into the future to make the monumental investments required.

As a result, investments in wind energy continue to grow. The U.S. Energy Information Administration (EIA) expects that installed capacity for wind power will increase by 10% by the end of 2016, and it will increase another 11% next year. Also, the first U.S. offshore wind farm is set to open this fall at the Block Island Wind Farm off Rhode Island.

Which means the wind energy industry is going to require a lot more bearings, gearboxes and related components over the next few years.

You can read about how massive 5-megawatt wind turbines are controlled in our case study from Beckhoff Automation, which begins on page 26. You can learn about all the different types of bearings required by wind turbine applications in this issue's Bearing Brief from the Bearing Specialists Association (p. 30). Or you can dive deep into the technical aspects of wind turbine gearbox lubrication by reading the technical article beginning on page 56.

But there's more to energy than simple electricity. Energy is also a feeling. Some mornings you wake up with more of it than others. And some times of year you feel more energetic, too.

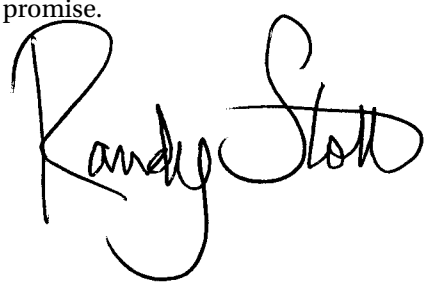
For me, fall is one of those times. The kids are going back to school. The United States is about to elect a new president. Businesses are starting to think about next year, and hopes and dreams are being put down on paper in the form of budgets and sales forecasts. Fall is a time of great change. And for me, the natural sense of energy comes with the season.

And oh, yeah. Fall is also trade show season, which means we have increased opportunity to find the technologies and meet the people who can help us hit those goals we put on paper.

This issue we're focusing on IMTS, MDA, IANA and the related shows taking place at Chicago's McCormick Place September 12-17, with our coverage beginning on page 38. We've tried to highlight some of the booths and exhibitors who offer the mechanical motion components that you might need to keep your factory running or that could be designed into your next project. The importance of IMTS continues to grow for those who buy and use mechanical components. It's always been a show for those who make components, but with the addition and continued growth of the MDA and IANA portions, readers of *Power Transmission Engineering* should find a lot more of interest than in years past.

We'll be at the show, in booth N-7324. I hope you'll stop by for a visit and let us know how we're doing. Renew your subscription, chat with the editors, or just say hello.

And if you find yourself in need of some energy, we're giving it away for free. Come to the *Power Transmission Engineering*-sponsored charging station (located at the entrance to the East Building) and plug in your cell phone or tablet. You'll feel energized, I promise.



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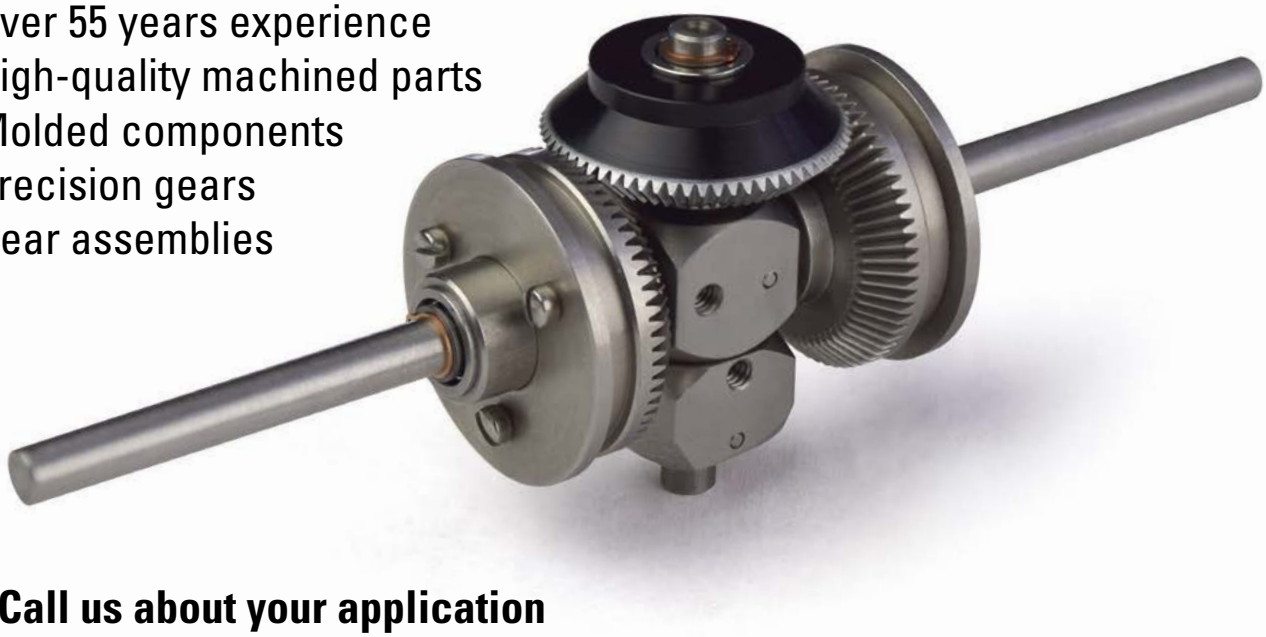

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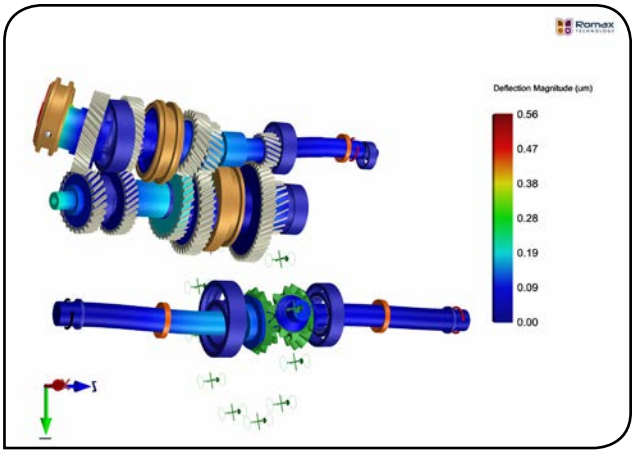
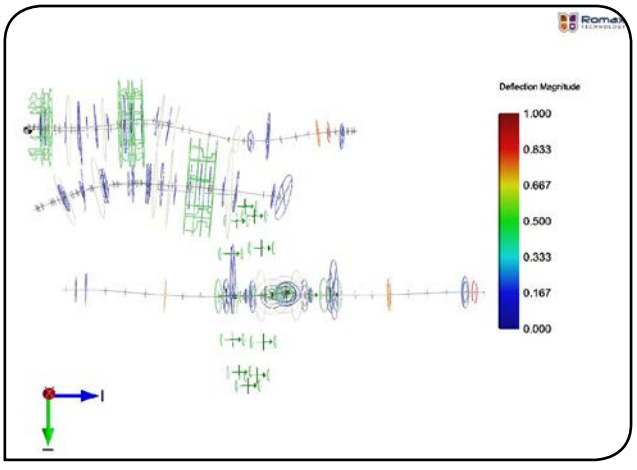


Example of mode shape analysis in *RomaxDesigner*.

Romax Technology offers simulation software that allows designers and manufacturers to assess and optimize NVH characteristics while also maintaining or improving efficiency and durability. Issues can be identified at the design stage, checking basic analyses for NVH at a concept level, saving both time and money. Volkswagen Group is one such company that Romax has supported to provide a holistic approach to their design process using *RomaxDesigner* software for gearbox simulation.

Europe's biggest carmaker, Volkswagen Group delivers over 10 million cars to customers each year. Almost one in four new cars (24.8 percent) in Western Europe are made by Volkswagen, a group which comprises 12 leading brands from seven European countries: Volkswagen Passenger Cars, Audi, SEAT, ŠKODA, Bentley, Bugatti, Lamborghini, Porsche, Ducati, Volkswagen Commercial Vehicles, Scania and MAN.



Example of schematic view of mode shape analysis in *RomaxDesigner*.

Its challenge was to develop a reliable validation strategy for gearbox NVH to allow design changes to be made with confidence. Romax's whole system simulation environment offers both a prevention and cure strategy for transmission NVH issues.

Employing over 15,000 people, Volkswagen's primary transmission site at Kassel, Germany, supplies about four million manual and automatic transmissions every year. Volkswagen engineers at Kassel have used *RomaxDesigner* software for more than five years, to support the effective production of gearboxes and to ensure the required NVH quality is achieved. Kassel's Acoustics and System Simulation department focuses on NVH correlation and simulation: "Our main challenge is gear whine, and the need to support our high acoustic standards," said Carsten Schmitt, Ph.D. student of Volkswagen's postgraduate program. "NVH is such an important issue in the industry today because of the rise in electric motor developments, and the simultaneous increase in the production of complex gearboxes. We use *RomaxDesigner* so that we can perform accurate simulation of these new gearbox designs, and assess the NVH performance."

From trial and error to simulation for development

Previously, sporadic correlation studies on the main parts of a gearbox would be conducted based on eigenfrequencies, which allowed for little correlation guarantee. "We have a requirement to develop simulation models that are representative of the real world, so that our design changes can be made with confidence," said Schmitt. "This gave rise to the need for an integral validation strategy, which we investigated in *RomaxDesigner*. We have already used the software for over five years on multiple projects. The speed and unique system-level simulation which *RomaxDesigner* offers stand it apart from other products currently available on the market."

An integral validation strategy

The strategy developed by Volkswagen focuses on a step-by-step process, allowing correlation between measurement and simulation along the acoustic transfer path at each of the following stages: gear excitation, shaft systems, bearings, gearbox housing, and whole vehicle testing. "If test and simulation are compared only at the end of the system development, then it is not possible to work out where discrepancies may arise, hence the need to perform correlation at each level. This gives us an understanding of exactly where problems are occurring, so that we can resolve validation errors quickly and easily, and avoid time-consuming investigatory work," Schmitt explains. "And Romax software plays a big part in this investigation. Only with *RomaxDesigner* can we quickly and accurately investigate gear whine phenomena on a system level – looking deeper into models to work out where the problems are. This is what allows us to meet high expectations for NVH within even the most cutting-edge system designs. Romax's unique system level view is a huge benefit to us, as well as its easy-to-use bearing catalogs, which make it easy to model gearboxes even if you are not a bearing expert, and its reliable and accurate transmission error calculations."

A step-by-step process

The gears are validated first, with testing and simulation performed across a range of loads. The gear contact pat-

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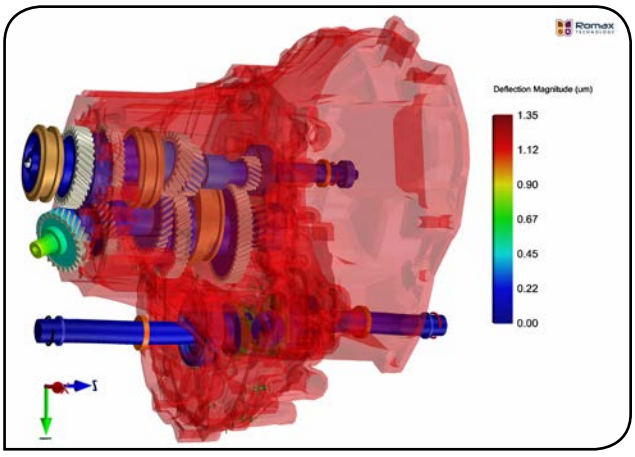
tern is checked; poor correlation indicates either incorrect micro-geometry in the simulation, or deviations in the manufacturing process. The next stage is shaft system validation, which consists of modelling single parts and assemblies, then performing finite element analysis (including pretest analysis and experimental modal analysis, if necessary). This is again validated against test data, and if this is unsuccessful the model must be updated in *RomaxDesigner*. Whenever correlation is not successful, changes can be made which will improve the process for the future, as Schmitt explains: "In the first run we found that the model needed updating. The updates that we performed, including accounting for Young's modulus and part-to-part stiffness connections, improved the correlation significantly."



Example of mode shape analysis including housing in *RomaxDesigner*.

The third stage is correlating the bearing stiffness, and the final step is the correlation for the gearbox housing, for which there are two options, as Schmitt explained: "The validation can be performed by building up the components separately using different tools and testing each individually, and then adding them together to make the final model. Alternatively a single model can be created in *RomaxDesigner*, which means just one experimental modal analysis, one correlation analysis, and only one model to update. We found that there was little difference between the methods, so the full housing assembly was done in order to save time and effort – this is a very useful way of doing the correlation."

"Now that we have developed the framework, we are confident the work we have put into this implementation will enable time and cost savings for future projects, as well as maintaining our customer's trust in our ability to deliver their requirements," Schmitt concluded. "We have developed a clear strategy to perform straightforward model updating procedures, and extended the validity and trust of our Romax gear whine models. Our design changes are not reliant on trial and error, but are based on proven, trustworthy simulation."

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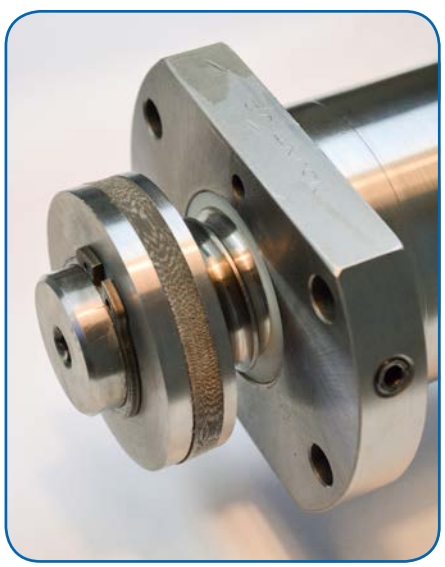
OFFERS SPECIALIZED ELASTOMER WASHERS TO PROTECT BALL SCREWS AGAINST SHOCK LOAD DAMAGE

Protecting industrial machinery and equipment against shock and vibration is a key requirement for keeping manufacturing operations running smoothly and minimizing downtime. Damping pads are often used to achieve these goals, cushioning equipment and absorbing shock and impact before these forces can have a negative impact on productivity. As an example, PAD plates from Ace Controls are widely specified as shock-absorbing underlayment for industrial presses and large machinery in manufacturing plants, underneath cranes and pipelines and in a wide range of other heavy-duty applications.

Because these rugged fiber and elastomer pads offer such high performance in absorbing shock loads, PAD material is now being specified not just as a way to support heavy machines but also as a way to absorb shock within the machine. One example is PAD's recent adoption as an impact-damping washer in a line of robust ball screws from SKF.



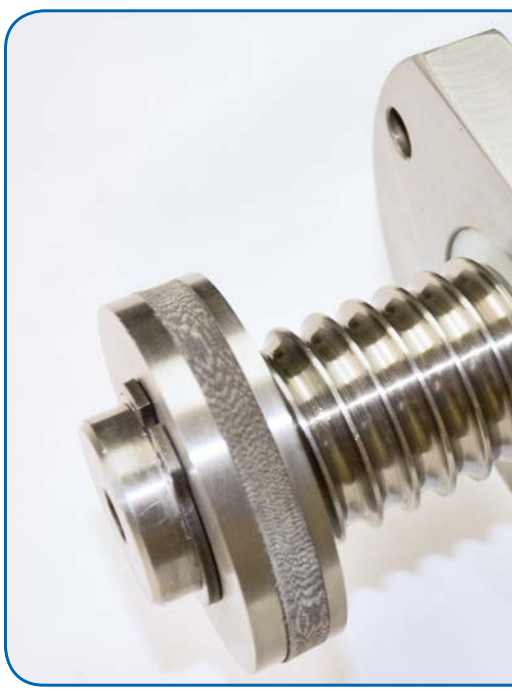
Overtravel Protection

In this design, PAD washers are inserted between a pair of steel washers and secured by a snap ring at each end of the ball screw. The elastomer washers act as an additional safety mechanism in the event of a machine malfunction and serve to absorb shock loads that might otherwise cause permanent and costly damage to the ball screw itself. Here's how it works: As the nut travels along the ball thread length, there is a risk that the nut may overtravel either end of the ball screw. No matter how well the control system is designed, overtravel scenarios are an inevitable and common occurrence in linear motion applications, especially those involving high speeds and dynamic loads.

To prevent the nut from overtraveling the ball thread length, the PAD washer that is sandwiched between the two steel washers absorbs the shock of the nut when it makes impact. By absorbing this impact energy, the PAD washer helps to prevent machine damage and avoid costly repairs and downtime. Typical examples of shock-induced ball screw damage include cracked screws, broken encoder mounts and ruined raceways, all of which can be avoided by using a rugged elastomer washer as an additional safety feature.

PAD washers are not a replacement for components such as limit switches and end stops. Instead, they provide an inexpensive method of additional insurance against common and unavoidable overtravel crashes. Like an automobile bumper, PAD washers can permanently deform under excessive shock loads and must be replaced after a significant crash. However, keep in mind that replacing a washer for less than $100 is much more economical in terms of both time and expense than replacing a high-end ball screw that costs many thousands of dollars. It is far more economical to destroy a simple washer than a sophisticated screw assembly.

Other impact solutions for ball screws include neoprene washers and springs. However, neoprene often suffers from chemical compatibility issues and does not absorb as much



force at a given thickness compared to PAD elastomer washers. Springs may also be used as shock absorbers, but they are difficult to specify correctly and require a large footprint, taking up valuable ball screw real estate. PAD washers are much more forgiving than springs in terms of both specification challenges and design constraints.

PAD Washer Properties

Ace Controls offers its PAD material in several different shapes and sizes, including pads, washers and bushings. Since they're easy to produce in any diameter, all washer styles are customizable to fit a wide range of application needs. Loads range from 0 to 2,000 psi. PAD materials combine isolating elastomer damping with the reinforcing effect of fiber inlays, creating robust cushioning for a wide range of heavy-duty tasks. For example, PAD plates can withstand compressive loads to 10,000 psi (69 N/mm^2), depending on their size. The material can also be cut and built up in layers. The PAD material displays superior compression properties and a low creep tendency of roughly five percent when under a continuous static load. With regard to dynamic loads, these can be very high with large, fast-moving ball screws. PAD washers provide reliable protection as they can absorb shock loads as high as each ball screw's static peak load rating.

Due to its superior performance as an additional safety measure on SKF's high-precision ball screws, the company is now offering PAD washers as an option on its entire range of one to six-inch-diameter screw sizes. Customer feedback continues to be encouraging, with documented savings in terms of avoiding costly downtime for equipment repairs. Based on the success of this novel ball screw design, engineers at Ace Controls are now recommending the use of PAD material in applications beyond machine underlayment that require shock and vibration damping in an economical and reliable format.

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INTRODUCES NEW GEARHEADS FOR HIGHER PERFORMANCE

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Introduction

New industrial and commercial requirements have demanded the need for higher-performance gearheads to be mated with both subfractional and fractional hp induction motors. One company, Oriental Motor, has responded by developing the new KII gearhead family that has been combined with single- and three-phase induction motors that range from six watts (1/125 hp) to 200 watts (¼ hp). Permissible- or continuous-load torque has been increased by 100 percent in some gearhead models, and over 300 percent in others.

The gearhead types include the parallel shaft gearheads and, for higher torque capability, the hypoid gearhead in both solid shaft and hollow shaft configurations.

The New KII Gearheads

The new KII gearhead type was developed from the earlier K gearhead. It is a high-performance gearhead created to handle the higher application loads required by many new industrial applications. The KII in its parallel shaft configuration can be integrated to small, AC induction motors from six watts to 90 watts; they are in fact direct mechanical replacements for earlier world K gear motors. A right-angle hypoid KII gearhead has also been developed for those applications requiring a smaller footprint. It has a higher load capacity than many other gearhead types and is used with the 200 watt, one-quarter-hp AC motor.

The intrinsic strength of the KII family was increased in order to significantly raise the AC gearmotor torque. Figure 1 displays a graph of the permissible torque of the parallel shaft construction KII vs. K gearheads, when mounted on a one-eighth-hp (90 watt), AC induction motor. For example, a 50:1 gear ratio shows a permissible torque value of 31 Nm (275 lb-in) vs. 20 Nm (177 lb-in) — an improvement of 55 percent for the KII parallel shaft gearhead. The superior performance increases at a 100:1 gear ratio to 40 Nm (354 lb-in) vs. the same 20 Nm (177 lb-in) — a 100 percent improvement for the KII gearhead over the conventional K gearhead. Both axial and radial shaft loads for the parallel shaft KII gearhead are at least twice the original K gearheads' capacity.

A similar comparison between the KII hypoid gearhead and the older K parallel shaft gearhead indicates a much larger permissible torque value. The performance difference for a 100:1

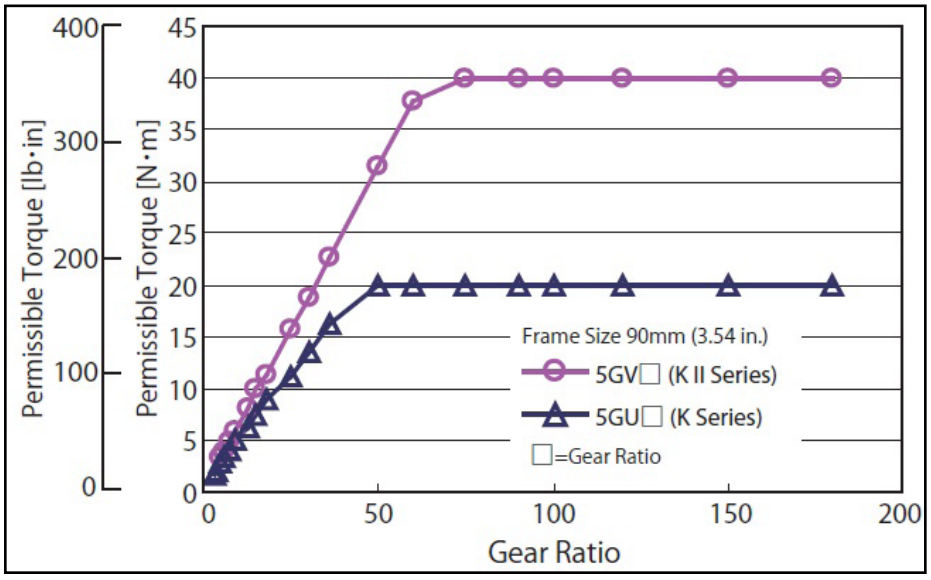


Figure 1 Comparison maximum-permissible torque parallel shaft gearhead 90 W (⅛ hp).

gear ratio is 50 Nm (442 lb-in) for the KII hypoid gearhead over the K parallel shaft gearhead at 20 Nm (177 lb-in). It increases to 70 Nm (620 lb-in) the KII hypoid gearhead over the K parallel shaft gearhead, while maintaining its 350 percent advantage at 150:1 (Fig. 2). The radial and axial shaft loads for the KII hypoid gearhead exhibits similar improvement percentages over the conventional K gearhead.

What has been done to achieve these impressive improvements?

New KII Parallel Gearhead Improvements

Two design changes have achieved the improvements within the new KII gearhead structure. First, the many internal gears receive a special carburizing heat treatment. By hardening only near the gear surface, tooth-bending strength and surface pressure strength are significantly improved; impact strength is also improved. Second, the KII gearhead family does not have a housing that supports the bearing via the retaining plates. Rather, its structure was revised so that a larger bearing is directly held within a gear case and gear flange. This enables the bearing diameter to be enlarged; see Figure 3 for KII parallel gearhead configuration.

Another manufacturing process adds a fine finishing treatment on the gear tooth surfaces. Compared to the K gearhead, the KII gearhead noise has been reduced by 6 dB due to this additional operation, shown in Figure 4. The noise testing was done on the 90 watt induction gear motor.

Hypoid Gearhead

A hypoid geared motor is often used in applications because the gearmotor can be mounted perpendicularly to the motor drive shaft. The hypoid gearhead uses a small hypoid gear that interfaces to a smaller motor shaft gear. It then interfaces to a larger hypoid gear (Fig. 5).

A hypoid gear is in the same gear category as the worm gear in spiral bevel gearing. This is for using the largest possible bearings. The pitch circular diameter of the small gear is larger than the other right-angle gears.

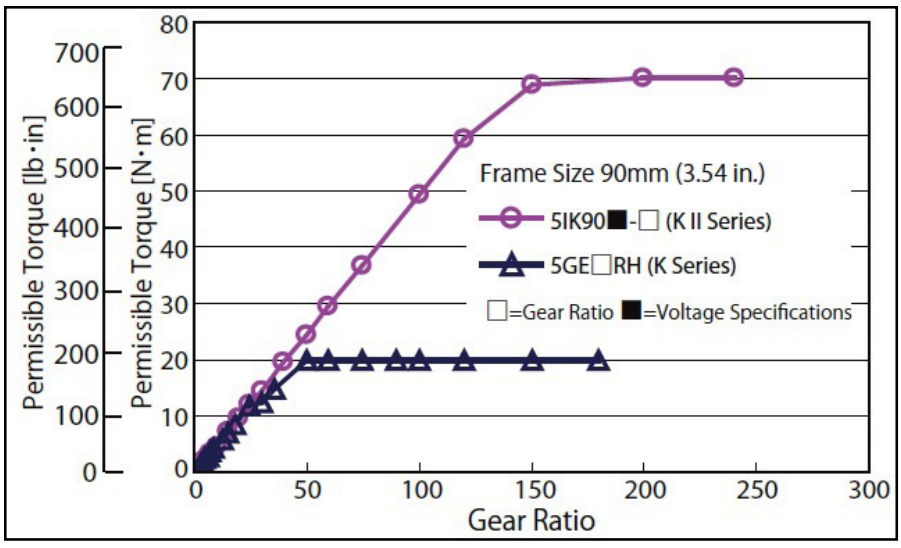


Figure 2 Comparison maximum-permissible torque hypoid gearhead 90W (⅛ hp).

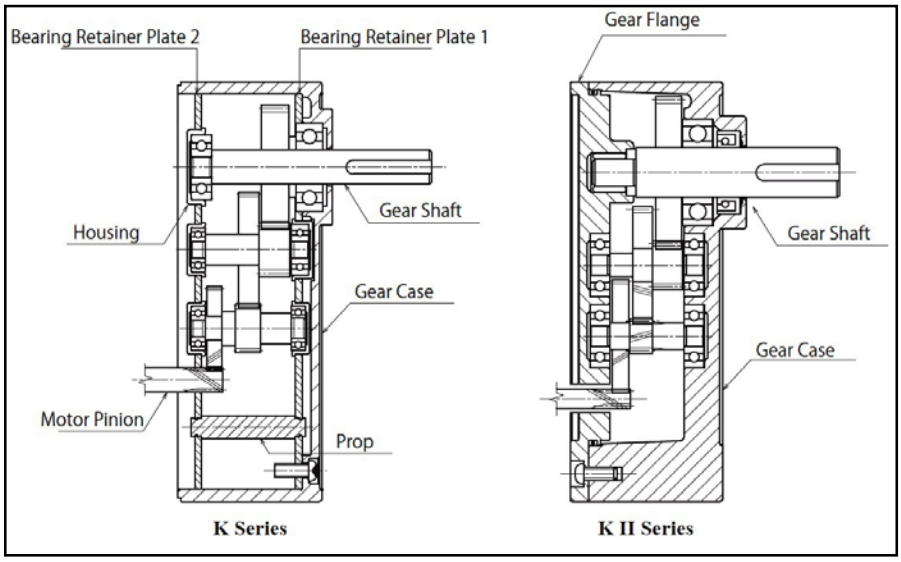


Figure 3 Structural comparison of parallel shaft gearheads.

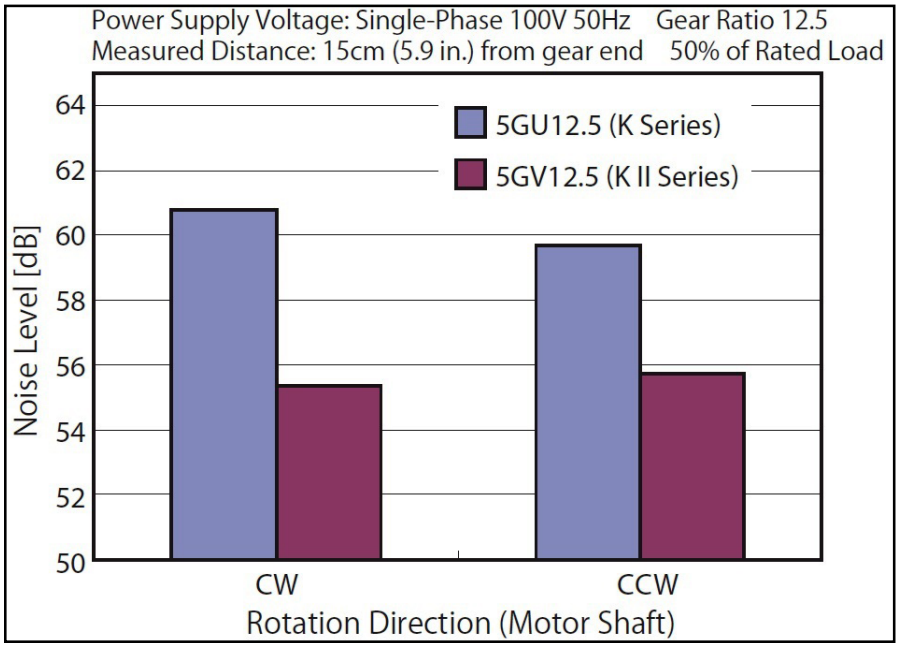


Figure 4 Noise level comparison of parallel shaft gearhead 90W (⅛ hp).

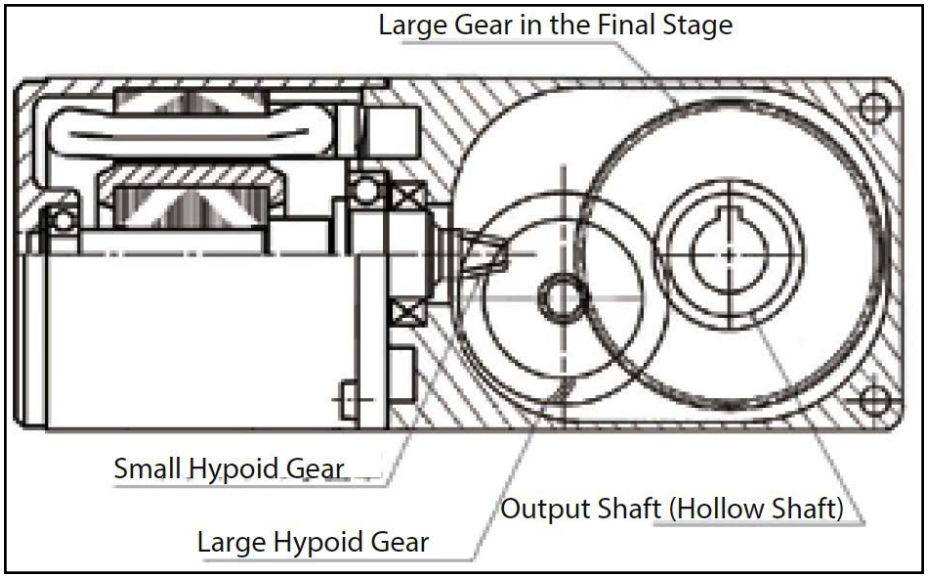


Figure 5 Structural drawing of hypoid gearmotor.

Therefore the small hypoid gear (that is larger than the worm and bevel types) offers more strength and a higher meshing ratio. It is also possible to increase the hypoid gear ratio by reducing the number of teeth on the small gear. In the areas where the two gears mesh/slide extensively is a complicated motion. The hypoid gearhead's advantages include higher gear strength, higher gear ratios, and higher transmission efficiency. This does result in a higher manufacturing cost.

Extending Motor Life

The new construction revisions for the KII gearhead have improved the operating life to 10,000 hours, or twice as long as the original K family gearheads. The KII hypoid gearhead requires a more comprehensive solution. There are two major causes of leaking lubricating grease. One is due to worn seal lips; the other is due to performance degradation caused by highly repetative bidirectional operation. In order to prevent the grease from leaking, highly reliable oil seals are installed in three areas including the I/O shaft location (Fig. 5). The new seal structure for the hypoid gearhead is designed to operate for 10,000 hours.

The KII family redesigns have significantly improved overall torque and power performance, including development of the KII hypoid gearhead for much larger application loads. The doubling of the KII gearmotor's operating life has been well received by the industrial equipment maufacturers.

For more information:
Oriental Motor Company
Phone: (310) 715-3300
www.orientalmotor.com

Dan Jones received his B.S. degree in electrical engineering from Hofstra University and a M.S. degree in mathematics from Adelphi University. He has since 1962 been a chief engineer and staff engineer with numerous companies. Either as a direct employee or consultant, he has applied his technical skills and experience working on DC motors, step motors, AC motors, brush and brushless motors, electronic drives, and on control systems in applications for the military, industrial, and commercial markets. Jones is a former president of the Association of International Motion Engineers (AIME) and has served on the Board of Directors of the Small Motor Manufacturers Association (SMMA). Jones is now president of Incremotion Associates, a firm combining the capabilities of engineers and marketing focusing on the motion control and power conversion industries.

Pittman

OFFERS COMPACT ENCODERS FOR OEM DESIGNS

The new Pittman E21 family of 21 mm optical incremental encoders satisfy the demands of volume OEM precision-motion control applications. The E21 represents a huge improvement over its predecessor with a 40 percent lower profile, multichannel outputs and options yielding up to 32 times the resolution and up to 24 times the frequency response. Creative packaging also makes this an economical drop-in replacement for other encoder providers.

The E21C and E21D encoders are 5 V, two and three channel optical encoders available in many different configurations. This modular encoder package comes in a compact size with alternate mounting arrangements. Connections are available in a locking radial or optional axial connector in addition to standard radial. The E21C and E21D encoders operate from -20 to +85°C and weigh only 2.5 grams.

The E21C encoder has resolutions of 120, 125, 128, 200, 250, 256, 300 and 360 CPR. It outputs two-channel quadrature signals that are TTL compatible and available with optional complimentary channels. Operating frequency is 40 kHz (100 to 360 CPR).

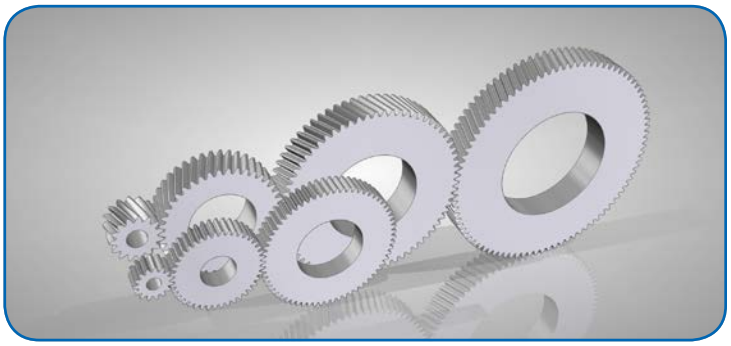
The E21D has resolutions of 500, 512, 1000, 1024, 1600, 2000, 2048, 3200, 4000, 4096, 6400, 8000 or 8192. It outputs two-channel quadrature signals that are TTL compatible with an optional third channel index output. Complementary outputs also are available. Operating frequency is from 55 kHz to 960 kHz depending on resolution.

The E21C and E21D encoders are available in kit form and adapt easily to many Pittman motors. The E21 will fit shafts of different diameters up to 5 mm. Prototype encoders are available now on request.

For more information:
Pittman Motors (Ametek, Inc.)
Phone: (267) 933-2105
www.pittman-motors.com

GWJ Technology GmbH

OFFERS NEW CALCULATION MODULES FOR CYLINDRICAL GEARS



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

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

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

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

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

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

Brother Gearmotors

UPGRADE CONDUIT BOXES FOR EASY INSTALLATION

Brother Gearmotors, a division of Brother International Corporation that offers a wide range of ultra-reliable, sub-fractional AC gearmotors and reducers for the food and beverage, packaging and material handling industries, is introducing new, larger conduit boxes – complete with stud type terminal blocks – as a standard offering for its 1–3 horsepower gearmotors.

All orders placed after July 1 will come with the next-generation conduit box and stud type terminal blocks. The upgrade replaces existing E-Boxes and features several important benefits including increased efficiency, easier wiring, quicker installations and greater flexibility.

All Brother gearmotors in the 1–3 hp range are compliant with the new government (DOE) mandate for small electric motors that took effect June 1, 2016.

"We anticipate complete satisfaction with our new conduit boxes, and believe their efficiency and flexibility will enhance our customers' experience with Brother's high-efficiency, hypoid bevel gearmotors," said Matthew Roberson, senior director of Brother Gearmotors.

For more information:
Brother Gearmotors
Phone: (866) 523-6283
www.brother-usa.com/gearmotors

Ruland Beam Couplings

BENEFIT STEPPER- AND SERVO-DRIVEN SYSTEMS

Ruland beam couplings are designed to couple stepper and servo motors to encoders, lead screws, and light duty actuators in a variety of industries. They are zero-backlash, have high torsional stiffness, accommodate all forms of misalignment and have a balanced design creating a highly accurate and flexible coupling.

Stepper and servo driven systems benefit from the multiple beam design of Ruland couplings. They consist of two overlapping spiral cuts to increase torque capabilities and torsional stiffness when compared to the commodity style single beam coupling. Separating the spiral cuts into two sets gives the coupling better parallel misalignment capabilities while easily accommodating angular, complex, and axial misalignment.

Ruland beam couplings are available with four or six beams in inch, metric, and inch to metric bore combinations ranging from 3/32" (3 mm) to 3/4" (20 mm). Four beam couplings are more flexible with lower bearing loads and are ideal for encoders while six beam couplings feature a larger body size with shorter spiral cuts to provide increased torque capability, repeatability, and torsional stiffness. Ruland manufactures beam couplings in 7075 aluminum for improved flexibility and low inertia or 303 stainless steel for higher torque capacity.

All Ruland beam couplings are designed and manufactured in our Marlborough, Massachusetts factory. They are made from select North American bar stock and utilize metric fastening hardware that tests beyond DIN 912 12.9 standards. Beam couplings are RoHS2 and Reach compliant.

For more information:
Ruland Manufacturing Co., Inc.
Phone: (508) 485-1000
www.ruland.com

KISSsoft

INTRODUCES RAPID 3D MODELING IN KISSSYS

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

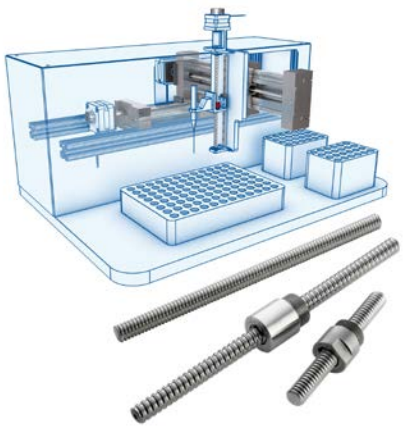
For more information:
KISSsoft USA LLC.
Phone: (815) 363-8823
www.kisssoft.com

Thomson Industries

EXPANDS MINIATURE METRIC BALL NUT STYLES

Thomson Industries, Inc., a manufacturer of mechanical motion control solutions, has built upon its selection of miniature metric precision ball screws to include three common interface styles: flanged, threaded and rounded. This comprehensive offering equips customers with even more options when designing small-space applications. These metric ball screws deliver a host of performance, supply chain and pricing benefits for users seeking smooth, quiet operation and best-in-class load capacities and lifecycles.

Joining the family's threaded style (TSI) mounting interface are flanged (FSI) and rounded (RSI) styles, which benefit from a unique multi-liner ball return system that provides smooth operation and increased load capacity. Ideal for laboratory, medical and mechatronics components, the miniature metric ball screws are available in a wide range of standardized diameters (Ø6 mm–Ø14 mm) to create a truly flexible solution. Though small in stature, they have been known to achieve twice the capacity of comparable models in most sizes.



With North American manufacturing and logistics, Thomson is able to provide customers with shorter lead times and lower-cost logistics. "Our state-of-the-art production facility precision-manufactures ball screws that help our customers design faster, safer and more optimized products for their customers," said Jeff Johnson, global product line manager – screws for Thomson. "We're also able to custom-machine screws and nuts within a matter of weeks to help meet customers' tight production schedules."

For more information:
Thomson Industries, Inc.
Phone: (540) 633-3549
www.thomsonlinear.com

Force Control Industries

POSIDYNE CLUTCH BRAKES REDUCE MOTOR SHAFT AND KEYWAY DAMAGE

Posidyne long coupled C-Face clutch brakes from Force Control Industries are an excellent option for high cycle (50 to 300 CPM) applications because they eliminate the damage to keyways and motor shafts that commonly occur. When indexing with a clutch brake, each clutch engagement transfers a torque spike to the connection between the motor shaft and the input shaft of the clutch brake. High cycle applications can cause continuous, severe, hammering on the shaft connection of the motor to the clutch brake. For convenience and ease of assembly, a standard C-Face connection is often used. In this arrangement, the motor shaft installs into the hollow bore of the clutch brake input shaft. However, the loose fit required for ease of assembly causes all of the torque to transfer through the key and keyway, resulting is early failure. A coupling that is shrink fitted or clamped to both shafts for a 360° connection transfers the torque through the shaft and not just the key. The long coupled Posidyne clutch brake offers both the simplicity of C-Face mounting, and the tight fitting coupling.

Posidyne clutch brakes feature oil shear technology that allow rapid and precise stopping, starting, reversing, speed change and positioning – all without adjustment and virtually no maintenance. Ideal for applications with frequent start/stop cycles, these unique motion control devices allow higher cycle rates (as high as 300 cycles per minute), increased production rates, all while reducing downtime. Higher production rates coupled with significantly longer service life than traditional (dry) clutch/brakes (five to 10 times longer in many cases) yields increased uptime, and improved productivity. No adjustment, virtually no maintenance, multi-year service life, minimal parts inventory, reduced parts and replacement ordering cost, adds up to higher production at significantly lower maintenance costs.

Designed with low inertia cycling components makes the Posidyne clutch brake more efficient, requiring less motor horsepower to accelerate the load, and less torque to stop the load. Their totally enclosed design is impervious to dust, chips, chemicals, coolants, caustic washdown, weather, and more, making them ideal for hostile environments.

For more information:
Force Control Industries
Phone: (513) 868-0900
www.forcecontrol.com

Leine and Linde

ENCODERS OFFER SPEED MONITORING

The Leine and Linde 1000 series rotary encoder with speed monitoring capabilities is used in applications where secure speed feedback is critical in order to protect motors, machinery or operators from risk of failure. This is especially useful on heavy moving machinery such as hoists, lifts, cranes and mining equipment, to name a few.

Leine and Linde's overspeed electronics on the 1000 series consist of a speed detection system that senses rotational speed and direction. These electronics control three different relay switches which can be programmed for identification of critical speeds or errors in direction. In addition, a fourth relay can be set to detect overspeed conditions, or be set to detect any functional error in the unit itself.

As critical speeds can vary for different applications, the ability to program application specific set-points offers considerable flexibility. With this capability, a standard 1000 series encoder with overspeed electronics can be supplied and programmed for each installation. Speed limits can be set for direction, over and under speed from 0 to 6,000 rpm. PC-based software is provided to configure the encoder using a standard USB port.

For more information:
Leine and Linde (Heidenhain)
Phone: (805) 562-1160
www.heidenhain.us

SG Transmission

DESIGNS AND MANUFACTURES
PERMANENT MAGNETIC CLUTCH

SG Transmission has designed and manufactured a permanent magnetic clutch for a global, medical device manufacturer, replacing the need for a brake and clutch saving money and weight.

The fail-safe clutch utilizes rare earth permanent magnets to generate the magnetic field keeping the clutch engaged, should the power fail. The innovative clutch was designed for a blue chip manufacturer to replace the existing clutch in a drive mechanism, which needed power to engage the clutch.

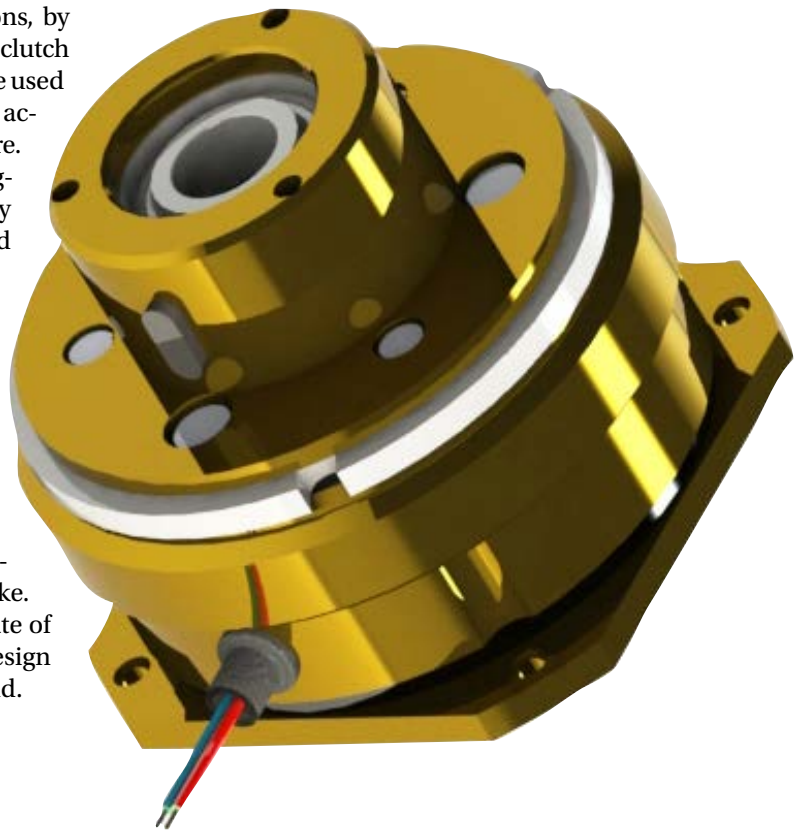
The existing configuration could, in the event of power failure, allow the mechanism to potentially become free moving in an uncontrolled manner. Standard practice would be to use a fail-safe brake in this arrangement to control the free movement, which would create an additional cost.

The innovative permanent magnetic clutch has the potential to replace both components and not only save space, weight and part count, but there is also a cost saving.

Paul Short, technical manager, said: "If the drive system uses a gearbox where the output shaft cannot be 'back driven' then, in some applications, by employing a permanent magnet clutch this mechanical advantage can be used to provide a positive stop/hold action in the event of a power failure. Therefore, the permanent magnetic clutch is suitable for many sectors including medical and military, where a permanently engaged clutch would be advantageous."

SG Transmission is one of the only U.K. electromagnetic clutch and brake manufacturers to offer the permanent magnetic clutch to a global portfolio. Earlier this year, SG Transmission launched the ultra-slim permanent magnetic brake. The manufacturer operates a state of the art facility and in-house design office in the north east of England.

For more information:
SG Transmission
Phone: +44 (0) 1388 770
www.sgtransmission.com



Amacoil/Uhing

INTRODUCES LINEAR MOTION SYSTEM

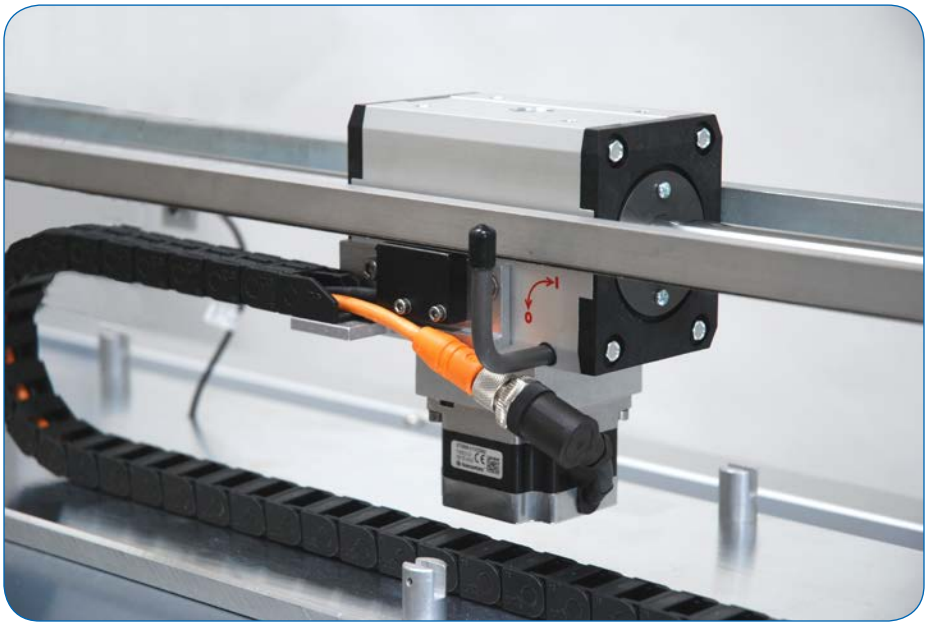
New from Amacoil/Uhing is the Precision Motion Drive System. This is a Model RG rolling ring linear drive integrated with a motion controller for precision linear motion applications. The Precision Motion Drive is fully programmable and meets application requirements for precision winding/spooling, pick-and-place machines, X-Y coordinate tool movement, metrology equipment and other machinery providing fast, accurate positioning and reciprocating linear motion. Depending on the size of the RG drive nut in the system, the Precision Motion Drive System provides from 7 to 800 pounds of axial thrust.

Linear movement of the drive head is defined via software and monitored by sensors feeding back to the electronic control unit. The Precision Motion Drive stores up to 20 programs which are easily recalled at the touch of a button. While meeting application requirements for most precision linear movement applications, the system is especially well suited for precision winding of a wide range of materials including wire/cable, PVC tubing, string, fiber, rope, rubber hose and vinyl strips. The new system also handles custom winding patterns and irregularly shaped spools.

The Precision Motion Drive System offers virtually unlimited flexibility with regard to specialized linear movement of the drive nut. Stop/start, travel direction, linear pitch, travel speed, repetitive processes, ramp up/down and essentially all other variables pertaining to drive nut movement may be programed into the system to meet application requirements. A single system may be set up to control multiple stations making it unnecessary to invest in multiple systems in order to help sustain high production rates.

A stepper motor controlled by a Siemens S7 PLC is included in the package. Fast, simple operation is enhanced with intuitive prompts displayed on a touch screen control panel. The shaft on which the Precision Motion Drive runs is smooth case hardened steel. There are no threads which makes the system useful in applications where particulate contaminants could fall into threads causing jams or clogs. The shaft rotates in one direction only. Drive nut travel direction, linear pitch and other motion parameters are controlled by the angle of the rolling ring bearings inside the drive unit. The angling and pivoting of the rolling rings is, in turn, controlled by user programming.

For more information:
Amacoil, Inc.
Phone: (610) 485-8300
www.amacoil.com



Alliance Sensors

EXPANDS PRODUCT OFFERING WITH LR-19 INDUCTIVE LINEAR POSITION SENSORS

H. G. Schaevitz LLC Alliance Sensors Group has expanded its sensor product offering by adding a line of LR-19 Series Inductive Linear Position Sensors using LVIT Technology; contactless devices designed for factory automation and a variety of industrial or commercial applications such as motor sport vehicles, automotive testing, solar cell positioners, wind turbine prop pitch and brake position, and packaging

equipment. With their compact design and excellent stroke-to-length ratio, LR-19 sensors are ideal for both industrial testing laboratories and OEM applications. Operating from a variety of DC voltages, the LR-19 series offer a choice of four analog outputs and all include ASG's proprietary SenSet field recalibration feature. The LR series also includes two larger body versions, the LR-27 and LRL-27, for those applications needing a heavier duty unit and a spring loaded version called the LRS-18. Technical data sheets and additional information can be found at the website below.

For more information:
H. G. Schaevitz LLC, Alliance Sensors Group
Phone: (856) 727-0250
www.alliancesensors.com

Haydon Kerk Motion Solutions

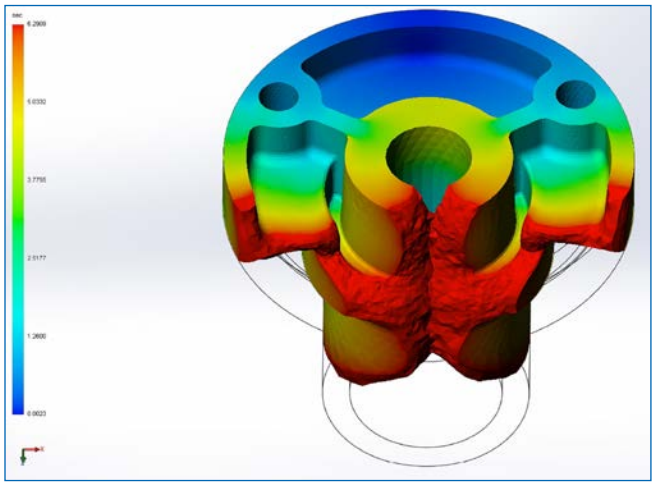
ADDS MOLD FLOW ANALYSIS SOFTWARE TO LINEAR MOTION SOLUTIONS

Haydon Kerk Motion Solutions recently added a powerful mold flow analysis software to help with the design of custom-molded lead screw and linear motion components. *Solid Works Plastic Professional* is an engineering tool used by Haydon Kerk's experienced tooling engineers to help speed up the design process and offer customized solutions to fit customer's application needs.

The use of mold flow analysis helps engineers run critical calculations to expedite the design of custom part and mold features, such as gate location, parting line location, design geometry, material flow, fiber alignment, vent locations, weld-line analysis, and cooling-line locations. All of these design considerations affect custom parts in areas such as ease in part strength, reduction in part voids/improved fill, reduction in cooling/cycle times, reduction in material waste and more.

Haydon Kerk's experience with the use of over 60 molded materials, including the Kerkite composites, PEEK and PPS base materials, combined with the capabilities of this new software, allows engineers to reduce the time required for the design and build process for custom molds. The combination of on-site tooling and molding machines also reduces the time to production for custom parts for existing Haydon Kerk polymers or customer-specified materials.

For more information:
Haydon Kerk Motion Solutions
Phone: (203) 756-7441
www.haydonkerk.com



Haydon Kerk has added mold flow analysis software to help with the design of lead screw and linear motion components.

Modular Control Systems for Wind Energy

TwinCAT 3 runs 5-megawatt wind turbine installation in China

Stefan Ziegler, Dipl.-Ing., Beckhoff Automation

For a 5-megawatt wind turbine prototype, aerodyn employs the latest control and software technologies, including a comprehensive PC-based control solution and the new modular TwinCAT Wind Framework. The TwinCAT Wind Framework features the latest software engineering and Big Data applications to extend current Industry 4.0 concepts to the wind energy industry. The modular software supports, for example, the direct provision of sensor data to the operator's database, and in general enables the easy adaption of the wind turbine operation management to future requirements.

The engineering specialists of aerodyn Energiesysteme GmbH, based in Rendsburg, Germany, develop wind turbines and rotor blades. The company also offers redesign and improvement services, as well as licenses for existing system designs. The company's products are based on its modular aeroMaster technology, a three-blade rotor with electric blade adjustment and a variable-speed generator/inverter. The aeroMaster is available in three versions for different climate types, as well as for special wind categories, which enables worldwide turbine operation even in extreme wind speeds.

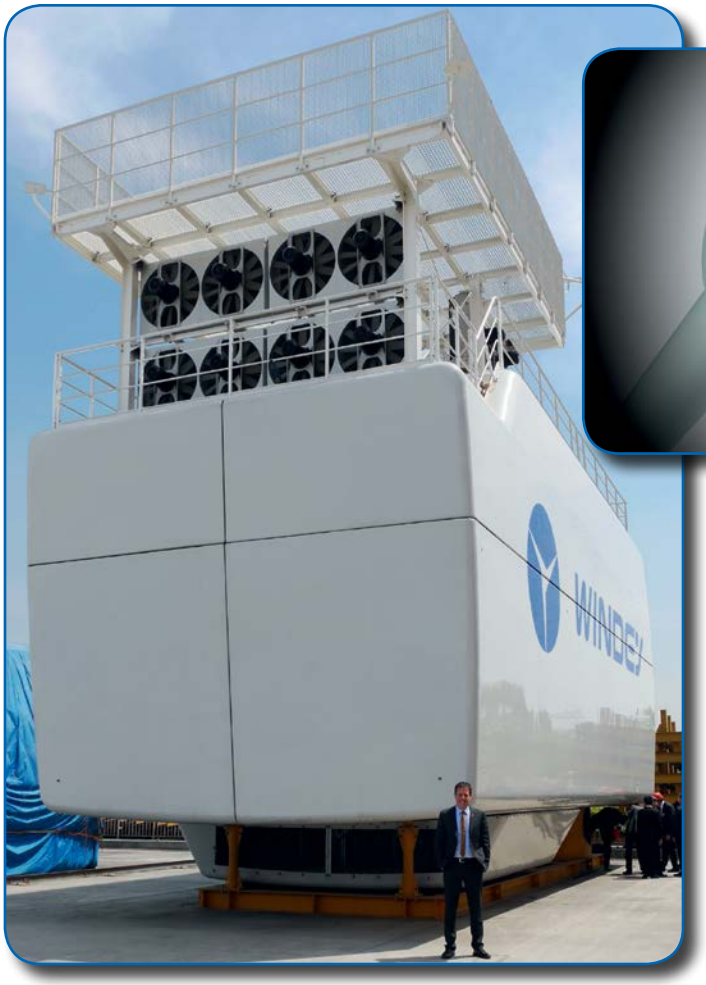
Intended for offshore installations and featuring a rotor diameter of 139 meters with a nominal power output of 5 megawatts, the new aeroMaster 5.0 was designed for wind conditions according to GL 2009 TC 2B, i.e. average wind speeds of 8.5 meters per second and a turbulence intensity of 16 percent, as well as for the highest requirements in terms of energy production and operating safety.

The prototype, which was built in collaboration with Chinese systems manufacturer Windey, also features redundant systems for more reliability, special ventilation, and climate control technology to prevent corrosion in the nacelle, as well as a rope-down platform for maintenance technicians.

5-Megawatt Installation Requires Extensive Control Technology

The electrical installation consists of three switching cabinets. The tower control cabinet contains the operating controls, the visualization system, the TwinSAFE-based safety system, and the equipment linking to the higher-level wind farm communication system, which is designed as an EtherCAT slave, ready for subsequent series applications. The control cabinet in the nacelle manages all nacelle and hub sensors and actuators, as well as the pitch control and inverter. The inverter cabinet, which is also installed in the nacelle, houses the inverters for certain fans and pumps, as well as the azimuth drives.

The control cabinet in the tower, which also provides easy maintenance access, houses the core of the control system. A Beckhoff CX2030 Embedded PC with an Intel Core i7 processor controls everything independently, i.e. without any remote access. What is remotely accessible, however, is the Beckhoff C6930 control cabinet IPC, which features an Intel Core i5 processor and an optional 256 GB solid-state drive. In addition to providing a remote maintenance access point, it handles monitoring and visualization functions via a Beckhoff CP2915 15-inch Control Panel. With its significant solid-state drive capacity, it also represents a powerful data storage system. Markus Rees, Managing Director of aerodyn, explains: "This is especially important with a prototype, for which we must collect much more data than would occur in normal operation. The control cabinet IPC and the Control Panel used for visualization purposes in the nacelle control



cabinet are, however, exclusive to this prototype and will not be required for the regular turbines."

The flexibility of the PC-based control solution delivers additional benefits, says Rees: "We benefit from the extremely broad and modular I/O spectrum. All in all, we cover 408 data points, which are recorded and processed via 218 EtherCAT digital I/Os, 110 EtherCAT analog I/Os, nine CAN masters, and two RS485 interfaces, as well as 31 IO-Link terminals, five encoder terminals and two power metering terminals. In addition, 33 TwinSAFE terminals are used for the personnel and machine safety systems, including emergency-OFF, overspeed protection, vibration protection and azimuth limit control. TwinSAFE has proven to be the ideal safety solution for wind turbines, because the TwinSAFE communication via standard EtherCAT can handle the long distances involved, including the option to use fiber optic cabling. Integrating the systems is also easy, because all safety data is available in the controller automatically and without any additional hardware."

EtherCAT has proven its value in wind turbines, not only because of the ease with which it handles the long distances between the tower base and the nacelle, which often exceed 100 meters. Also important, according to Rees, are the cabling redundancies and the extensive diagnostic capabilities, which make troubleshooting easy. The combination of all these features delivers high-performance communication capabilities for the core turbine components. Even the wind farm communication can be seamlessly integrated, as it was in the single prototype just installed, Rees notes.

TwinCAT Wind Framework supports modular concepts

The aeroMaster 5.0 from aerodyn is the first wind turbine installation that employs the TwinCAT 3 software generation and the new TwinCAT Wind Framework. With its modular design, the TwinCAT 3 Wind Framework fully supports the turbine's modular hardware design, which can include pitch systems, converters and generators from different manufacturers, because it provides control technology and wind industry expertise from Beckhoff in encapsulated modules and in an application-specific template. These modules include a wide range of services for wind turbine automation, as well as real-time access to all data and long-term database management. The application template provides a modular architecture that allows for quick and efficient engineering.

Markus Rees: "We use the full range of the TwinCAT 3 Wind Framework and have it linked to a Microsoft SQL Server database. Since the framework already comes with essential operating tasks, you no longer have to implement, modify, and maintain them. Our engineers can therefore focus fully on the actual turbine functions without worrying about basic operating functions. Also, the integrated and permanent data storage in real-time simplifies analyses and diagnostics considerably. In addition, the modular architecture of the TwinCAT 3 Wind Framework makes it possible to substitute individual software modules. We can easily reuse existing functions, as well as add new ones."

As Markus Rees explains, aerodyn also leverages the typical benefits of TwinCAT 3: "To determine extreme and regular operating loads, the controller algorithms from the wind turbine simulation can be easily taken from the source code and integrated as C++ modules. In addition, the integration into Visual Studio, coupled with source code management support using Subversion, has made project management and the collaboration among engineers in Germany and China considerably easier." **PTE**

For more information:

Beckhoff Automation LLC
Phone: (952) 890-0000
www.beckhoff.com

The Meaning of Life

Determining Lifespan for Lubed-for-Life Bearings

Ian Rubin, Regal Power Transmission Solutions

End users and OEMs frequently specify "lubed-for-life" mounted bearings, thinking the lubed-for-life bearings will deliver the same life—without lubrication—as bearings that currently require periodic lubrication. The truth is it depends on many factors, and only a detailed review of the application and testing will provide a more accurate answer.

As a bearing manufacturer, we are often asked why we cannot give a definitive answer. We would love to provide one, but it depends on many variables, even when application data is available.

Bearing manufacturers often provide "lubed-for-life" mounted bearings with a plug in the housing in place of a grease fitting, and some may add extra grease. In addition, you may see a tapered land design that helps direct lubrication back into the raceway. Then consider certain retainer designs can help a bearing run cooler. Even with these features and a very good seal, the most accurate answer to the question about bearing life still requires a detailed application review and testing. So, before you pull all of your bearing lubrication fittings and plug the holes, you need to understand why this is a gray area.

A retainer that rides on the outer ring land surface allows the balls to freely rotate in the cage pockets with a proper film of lube. A retainer that rides on the balls prevents the balls from rotating freely, so with every rotation grease is wiped from the ball.

First, let's clear up any misunderstanding that "life" means infinite life. Under correct application conditions, properly installed and properly maintained, your mounted bearing's life is limited to its L10 life or rating life calculated using industry standards.

What is L10? The L10 life is the number of revolutions or hours that 90 percent of a group of apparently identical bearings will complete or exceed before fatigue is expected to occur. In other words, 10 percent of the group is not expected to achieve the L10 life. The rating life can be calculated in terms of millions of revolutions or hours by using the bearing Basic Dynamic Rating (BDR). BDR is a calculated value, based on the bearing's geometry, and represents the constant load which 90 percent of a group of apparently identical bearings can endure for a rating life of 1 million revolutions (33⅓ rpm for 500 hours).

The basic load rating is a reference value only, to be used for selection of an adequately-sized bearing to provide the desired L10 life in a given application. The L10 rating standard was originally established by the American Bearing Manufacturers Association (ABMA). Based on years of analysis very few bearings actually fail because of "fatigue." The cause is usually another factor, such as lubricant failure or contamination.

Grease is the word

Precise answers for bearing life are challenging because L10 life is based on ideal conditions, while real applications seldom duplicate those conditions precisely. A critical element in bearing life is the condition of the grease in the bearing. When the grease fails or gets expelled or contaminated with water, chemicals or foreign matter, bearing failure follows.

Grease is made up of 80 to 90 percent oil and the balance a thickener (often referred to as "soap") and additives. The oil provides the protective film between the rolling elements and raceway surface. The bearing will run smoothly until the grease breaks down. As the lubricating film between the rolling elements and raceway degrades, metal-on-metal contact begins.

Grease is affected by application conditions and the environment. Application factors that affect grease life are load, speed and ambient and operating temperatures. Heavier loads and higher speeds increase bearing internal temperatures, hastening lubricant breakdown. Likewise, two identical bearings under the same loads and speeds will have vastly different grease lifespans when one is in a climate controlled facility, while another is positioned near a 500°F (260°C) oven. A good rule of thumb is that for every 18°F (10°C) of temperature rise, the grease maintenance cycle should double in frequency.

Environment often plays a bigger role in grease life. Is the environment wet, dry, or gritty? Is the equipment washed down—how? What chemicals or cleaners is the bearing exposed to? Is the bearing housing protected from water blasts or foreign material ingress? Does the bearing have appropriate seals?

There are many types of protection for mounted bearings, including protective end caps and backside seals. No single style or seal design is perfect for all applications.

Some seals last 10 times longer than others in lab test-

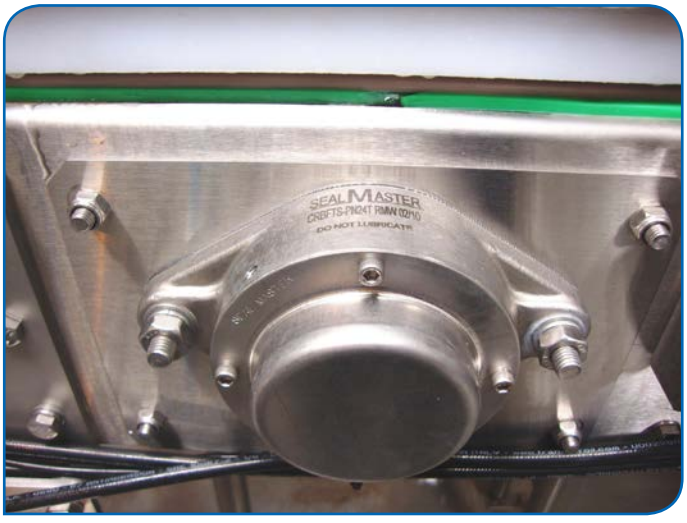
ing, but better sealing typically increases drag and frictional torque, which can be undesirable in some applications. The best seal for a given environment may not always be the best for the application. And even the best seals can be penetrated by overzealous cleaning crews with high-pressure spray equipment.

Even bearings in a parcel distribution center can be contaminated by particles of paper or packaging material dust, and certainly gritty dusts in a wood processing plant, quarry, or grain handling operation require excellent seals — and re-lubrication, if possible.

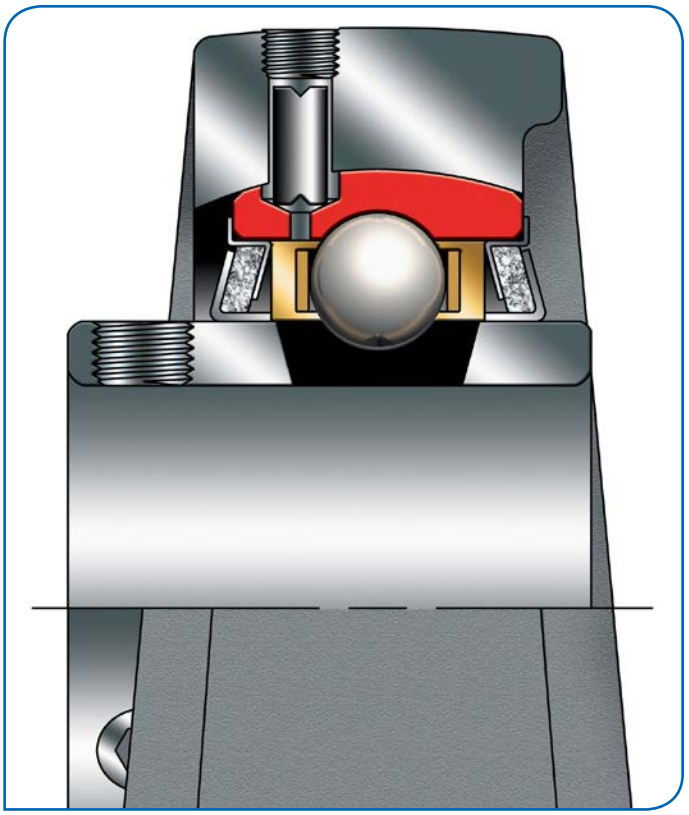
L10 adjusted and improved

The ABMA provides a means to modify the L10 rating with "adjustment" factors, known as a_1, a_2, a_3 that are applied to the standard L10 value in order to determine an adjusted rating life (L_{na}). The a_1 factor accounts for fatigue life based on reliability other than 90 percent. The a_2 factor accounts for the bearing material. For example, standard bearing quality steel sets a baseline factor of 1.0.

The a_3 factor adjusts for operating conditions, such as lubricant quality, presence of foreign matter, conditions that cause changes in material properties, unusual loading or mounting conditions. Mounted bearings are typically slip fitted to the shaft and rely on features such as inner race length and the locking device for support. ABMA recommends an a_3 factor of 0.456 for "slip fit" ball bearings. Shock and vibration can act as an additional load over and above the expected applied load, also requiring an a_3 life adjustment. Accurate determination of the a_3 factor often requires testing and in-field experience.



The added protection of end caps and backside shields can significantly prolong the life of a sealed bearing in clean-in-place and steam-in-place applications.



Seal design and grease capacity can make a difference in lifespan of a basic mounted bearing. Sliding contact between a rubber seal and the bearing inner ring can lead to seal breakdown when debris gets under the rubber. A flinger-equipped labyrinth felt seal (shown) eliminates this sliding contact, and the flinger repels debris.

Protecting and replacing grease

In any given application running side by side, a properly re-lubricated bearing will always outlast a sealed "lubed-for-life" bearing. Re-lubrication provides fresh grease to the raceway and pushes old or contaminated grease away from the raceway. "Proper" lubrication means to avoid over lubricating and make sure the grease fitting and gun nozzle are cleaned before use.

Re-lubrication may not always be practical. It can be costly and may introduce more problems than no lubrication. But when specifying a "lubed-for-life" bearing, make sure you understand how your environment and application will affect grease life, because "life" never means forever. **PTE**

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Analyzing Wind Power

Equipment and Application Overview

Power Transmission Engineering is collaborating with the Bearing Specialists Association (BSA) on a special section within the magazine. *Bearing Briefs* will present updated reports on bearing topics for each issue in 2016. Complimentary access to all BSA Bearing and Industry Briefs is available on the BSA website at *www.bsahome.org/tools*.

Wind is a form of solar energy.

Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. Wind Turbines convert the kinetic energy in wind into mechanical power.

When the turbine blades turn, they rotate a low-speed shaft that is connected to a gear. This gear turns a smaller speed shaft that has a tighter rotation with greater torque, essentially concentrating the energy so it can move the rotor at much higher speeds than the wind moves the blades.

This process works by moving magnetic fields created by copper wire wound around a metal core, a common electromagnetic device. As the coils are turned and the magnetic fields shift, they create a charge that is then channeled in cables, creating a flow of electricity.

Wind Power Main Shaft

Application Overview

After the wind load is transferred through the rotor, the main shaft bearing transmits the rotational torque to the gearbox.

Bearing Applications

Self-aligning spherical roller bearings are mainly utilized for the main shaft bearings because of their superior aligning characteristics and load durability.

Items to Consider

When selecting bearings for the main shaft one must consider rotor rotational speeds, appropriate loads, the shaft, housing rigidity, and lubrication.

Wind Power Gearbox

Application Overview

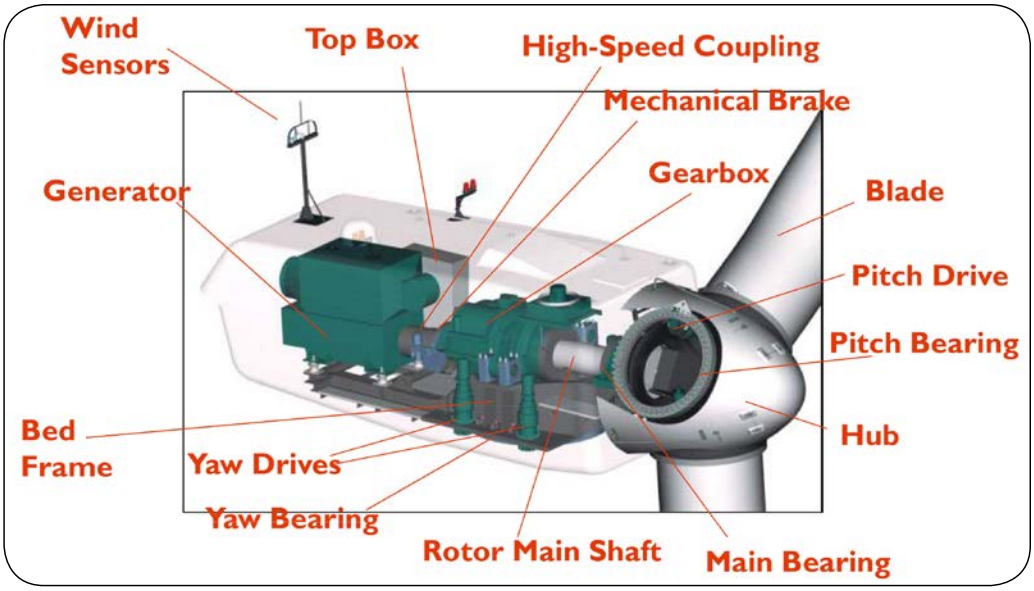
The gearbox is the component that increases the rotational speed transmitted via the main shaft up to the point where power can be generated. It consists of plant gears, a ring gear, a low speed shaft, an intermediate shaft, and a high speed shaft.

Bearing Applications

A combination of cylindrical and tapered roller bearings are used to support the loads generated by the gears. Special clearances are often used. Full complement bearings and bearings on high speed shafts are often coated in a friction reducing coating (black oxide) to prevent damage caused by skidding.

Items to Consider

It is also important to investigate the proper bearings for the gearbox using an analysis program similar to that for the main shaft. If the rigidity of the planet gear is low, the ring gear deforms, and this may have an influence



on the inner components and shorten the service life of bearings. Service life of gearboxes is a major concern of the wind industry.

Wind Power Generator

Application Overview

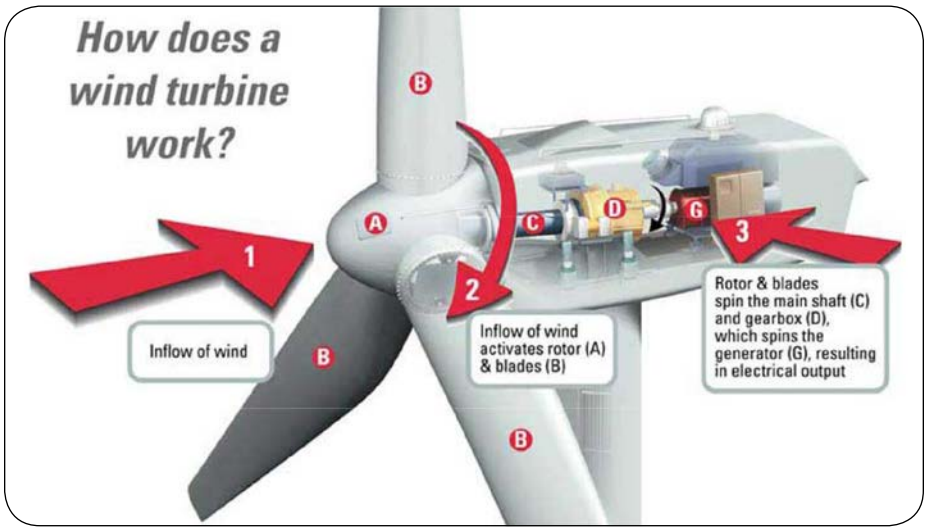
Generators convert the mechanical energy obtained from the wind into electrical energy.

Bearing Applications

Radial ball bearings are the most commonly used bearing due to the low friction and capacity requirements of this application.

Items to Consider

Bearings used in generators are subject to electric pitting—a phenomenon where the surface melts locally because sparks are generated as the electricity passes through the ultra-thin oil layer and into the bearing while rotating. This is one of the main factors that can lead to damage and reduce bearing service life. To combat this ceramic balls are used providing excellent insulation performance, reduced operating temperatures when rotating, leading to improved life of lubrication and duration of preventative maintenance.



Pitch and Yaw

Application Overview

The Yaw Drive allows the turbine nacelle to rotate into the wind as the wind direction changes, as well as supports the nacelle on the tower. The Pitch Drive is used to feather the blade into and out of the wind to optimize blade angle leading to improved performance.

Bearing Applications

These applications require long periods in nearly stationary positions with large static and vibratory loads. Typically 4 point or 8 point contact ball bearings are used due to their capability to carry radial, thrust, and moment loads.

Items to Consider

For slewing bearing applications it is important to keep both bearing static capacity and stiffness in mind. One must also pay attention to the slewing rim gearing for optimum performance.

Operations and Maintenance

Turbines are designed for a 20 year life span — one of the biggest concerns facing Wind Farms today is how they should plan to operate after the OEM warranty period (typically 5 years).

79 percent of wind turbines were still under warranty in 2011, but that is going to be changing rapidly due to the large amount of installations in the past few years.

O&M costs for wind power are double or triple the figures originally projected. They are particularly high in the U.S. For example, O&M costs in 2011 averaged $0.027 per kWh, but were originally estimated to be $0.005 per kWh.

A significant amount of research is currently going into gearbox reliability — many gearboxes are failing after 6-8 years in operation.

(*Source: Wind Energy Update — The Wind Energy Operations & Maintenance Report*) BSA extends special thanks to Jaime Lox, Koyo Corporation, for his help in preparing this Industry Brief.

Recommended Operations and Maintenance Practices

There is a tendency to focus on blades, gearboxes, and generators but even low value component failures such as a loose bolt can lead to severe revenue losses — making regularly scheduled inspections critical: Visual inspections, blades, videoprobe, thermal imaging, vibration monitoring and oil and grease analysis should be considered. **PTE**

Avoiding Downtime and Revenue Loss

Component	Probablity of Component Replacement or Refurbishment	Cost (% of the WTG Cost)	Estimated Downtime (Weeks)
Tower	Very Low	22%	6-10
Hub	Very. Low	16%	4-8
Gearbox	High	14%	2-4
Blade (Individual]	Low	6%	2-10
Generator	Medium	6%	2-4
Yaw Bearing	Low	3%	2-10
Main Shaft searing	Low	2%	2-4

Source: Wind Today Magazine - First Quarter 2011 Issue

For more information:

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High-Temp Bearing Replacement

Certified Bearing Specialist (CBS) Examines Radiating Temperature Issue

Richard (RJ) Seguin, CBS and technical sales representative at AMI Bearings, explains how his bearing expertise tripled the life of a customer's bearings.

"As a bearing and power transmission component salesperson, I am often called upon to help resolve issues that take away from efficient "uptime" with my customer base. Having done this type of work for over 30 years, I have a relatively firm grip of the concepts involved in keeping things running in an effective way. This, coupled with my refusal to ever compromise my personal integrity, have helped me gain the trust of my customers.

During a routine end-user call, to a wallboard manufacturing facility, I asked the board line maintenance manager the age old, but still pertinent question… "What is your worst (bearing) maintenance headache? As a Certified Bearing Specialist, I may be able to help alleviate the problem."

Just two days ago, they had to stop production, right in the midst of a very busy cycle, due to bearing failures on the kiln that cures the still-wet wallboard. They were down for two hours, and it cost them dearly.

While asking about the specifics of the application, I learned they were using standard 1 7/16" pillow blocks… nothing special at all. I was also told that they did change-outs of all the pillow blocks on the kiln, every three months, yet still had occasional failures. We learned that the OEM had used bearings that were fine for the ambient temperatures around the kiln, but they neglected to factor in the temperature as radiating through the shaft. There was also considerable moisture in the air, as the kiln forced the water out of the "raw" wallboard.

We measured the shaft temperature to be about 325°F, which was causing the grease from the standard 1 7/16" bearing to liquefy and leak out. There was also evidence of this all over the floor around the kiln. There was also rust that had formed on the visible surfaces of the bearing races. The rust stains on the machine frame suggested that all the bearings were suffering from similar inadequacies, although to a lesser degree at the dry end of the kiln.

I suggested they should go with a high temperature bearing, made of heat stabilized steel, with special high-temp seals and lubricant, to replace the standard bearings. The synthetic grease would easily stand up to the radiant heat, and silicone seals also would hold up, keeping the grease in the bearings, and the water out of them

They changed over a few bearings during the first scheduled three-month change cycle. With time, the customer realized at least a full year's performance, before even considering the need to replace the bearings, although, due to their nervousness, continued to change out the bearings, through the first year, a few at a time. They eventually left all the bearings in place and only replaced them during their annual shutdown. Even after the full year, the bearings turned freely, and displayed no signs of adverse running conditions. They will get adventurous and keep leaving a few bearings in place to see how long they actually last. Stay tuned…" **PTE**

For more information:

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Certified Bearing Specialist

BSA's Certified Bearing Specialist (CBS) program is the only bearing industry-specific program that identifies and quantifies the specific skill sets to certify an industry professional as a bearing specialist. The CBS program is all about developing the expertise to help customers and end users make the best bearing decisions. Take advantage of this complimentary access to a Certified Bearing Specialist. Please email your question to *info@bsahome.org*. An expert CBS will respond to your inquiry and it may appear in this article.

Richard Seguin has worked in the PT Industry for the past 30 years. The first 24 working for an industrial distributor and the past six years as a manufacturer's sales representative selling AMI product in Canada. His many years of experience coupled with his CBS certification forms a solid combination for success.

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2016 Motion, Drive & Automation Show
Everybody Loves US?

Jack McGuinn, Senior Editor

Q&A with Larry Turner, President & Chief Executive Officer Hannover Fairs USA, Inc.

With the addition of Hannover Fairs USA's Motion, Drive and Automation (MDA) and Industrial Automation North America (IANA), IMTS 2016 boasts a greater array of industrial and other manufacturing services than in previous shows. Industrial automation is happening in a big way — spurred by new motion-and-control technology advances and an ever-growing world economy. And you can see it all under one roof at IMTS 2016.

Larry Turner, president & chief executive officer, Hannover Fairs USA, Inc. is an executive with a clear track record for starting up, repositioning, revitalizing, and growing organizations; his particular areas of expertise are in business development; international sales; marketing; e-business strategy; Web development; and project management. Before joining Hannover Fairs USA in July, 2011 Turner was chief executive officer of Roundhouse Advisors, a business management consultancy. Prior to that Turner held positions improving operations and sales in companies such as BancTec, Bell & Howell, Canon and Wybron. He brings to his role ample experience in a wide range of industries, including high technology; office automation; fully integrated manufacturing-and-industrial automation; as well as medical device products and services. With IMTS rapidly approaching, Turner managed to make time for us to answer some pre-show questions.

> "The U.S. is a very attractive market for international firms with manufacturing solutions, and we see that trend continuing. This year (Hannover Fairs USA has) secured a tremendous amount of interest from international exhibitors and attendees, which demonstrate growing interest in the U.S. manufacturing sector."
>
> — Larry Turner, *president & chief executive officer, Hannover Fairs USA, Inc.*

PTE: This will be (parent company) Hannover Fairs USA's (HFUSA) third co-located IMTS. How has the partnership worked out thus far?

LT: Because there was such strong interest from IMTS 2012 and 2014 attendees, we decided to continue to expand our Industrial Technology Events Powered by Hannover Messe. The partnership continues to work really well for AMT and HFUSA.

PTE: Have you perceived any recent trends or developments in manufacturing that might indicate what kind of attendance to expect at this year's show?

LT: This year we have secured a tremendous amount of interest from international exhibitors and attendees, which demonstrate growing interest in the United States manufacturing sector. Exhibitors represent Germany, Italy, Netherlands, Taiwan, Canada, India, Korea, Spain, China, Turkey and Bulgaria.

PTE: On the other hand, do you believe current economic conditions necessarily dictate turnout at trade shows?

LT: In February, we sold out the exhibition space for all five Industrial Technology Events Powered by Hannover Messe. As the United States continues to expand its global manufacturing footprint, we expect attendance at our shows will surpass 2014.

PTE: Considering recent industrial manufacturing technology advances, what would you say have been the most significant developments since the 2014 show?

LT: The single most important development in manufacturing in the past two years has been the overwhelming discussion around and movement towards investing in Industrial Internet of Things (IIoT) programs and initiatives to help accelerate the era of IT-optimized smart manufacturing. As IIoT solutions providers better frame, define and create IIoT strategies, many organizations have started to look at what is possible in the age of Industry 4.0. Manufacturers around the world are now embracing the Internet of Things and smart manufacturing. Digital factory solutions will be showcased across all of the 2016 shows.

PTE: Please speak to the importance of the international partnership for the show.

LT: International participation has continued to increase over the past three events. This year almost 70% of the companies exhibiting have headquarters outside of the United States. The United States is a very attractive market for international firms with manufacturing solutions, and we see that trend continuing. The support from international trade associations has been one of the keys to increasing the international participation.

PTE: Are there ways that the partnership could grow in future?

LT: We expect the participation by international firms will continue to increase in future events.

PTE: How important are the educational programs being presented at the show?

LT: Very important! IMTS attendees have shown continued interest in our conference programs so we expanded our educational programs and are very excited about these new offerings.

This year, we will launch the **Integrated Industries Conference (IIC)**. The IIC will highlight trending topics across the Industrial Automation and Motion, Drive and Automation sectors. On Tuesday, September 13, IIC will feature global industrial tech experts who will discuss solutions to current manufacturing concerns and present a variety of advanced manufacturing topics. Presenters will share insights, best practices and new methods to help attendees thrive in today's dynamic manufacturing environment.

IIC topic track attendees will learn how to add smart technologies to their equipment to improve process efficiency, reduce downtime and increase product quality insights. Uniquely positioned IIoT technology thought leaders and providers Applied Manufacturing Technologies; MPDV USA; Rittal; it's OWL—Intelligent Technical Systems OstWestfalenLippe—a German technology and research hub; Bimba Manufacturing Corporation; and Control Station will discuss solutions for implementing Industry 4.0/IIoT, Predictive Intelligence Maintenance and Process Monitoring & Diagnostics.

IIC Motion, Drive & Automation topic tracks include: Compressed Air, Cost of Electric Actuators vs. Pneumatic Cylinders, Increase Production with Machine Safety, Linear Motors Motion Technology and Customizing Universal Joints.

On Wednesday, September 14, we are launching a Fluid Power Track as an extension of IIC where industry experts will address pneumatics and hydraulics in the manufacturing process and how to enhance energy efficiency.

Also on Wednesday, September 14, the third Global Automation & Manufacturing Summit (GAMS) will bring together industry experts from all areas of IIoT to discuss cloud-based manufacturing, robotics and maintenance. Technology leaders will explain IIoT and how manufacturers can implement and leverage this new business strategy to improve operations on the factory floor.

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

LT: We are excited about bringing the world's manufacturing executives and industry suppliers together in Chicago to experience and to showcase the most comprehensive solutions impacting today's manufacturing industry. We look forward

to demonstrating the most innovative technologies and solutions for smart manufacturing, and are excited about offering our exhibitors the ability to secure new business connections and to better gauge their global competition.

We are excited about the line-up of industry experts we have assembled across our conference tracks. These experts will discuss the most useful and up-to-date technical information available in today's manufacturing industry.

PTE: Can IMTS get bigger any time soon?

LT: We have had discussions with AMT, the organizer of IMTS, and we are working on activities that could result in an even larger, combined IMTS with our Industrial Technology Events Powered by Hannover Messe.

PTE: What are your expectations for this year's show? The biggest to date?

LT: Absolutely, this will be the biggest Industrial Technology Event Powered by Hannover Messe to date. We have doubled the size of our footprint and have significantly enhanced our conference offerings. **PTE**

Two Shows — Countless Opportunities

THE SHOW: INDUSTRIAL AUTOMATION NORTH AMERICA AT IMTS

Building on a successful show in 2014, Industrial Automation North America returns in 2016 as a co-located event with IMTS. Featuring the greatest-and-latest in factory, process, and building automation, this event has established itself as the place to see the automation industry's most innovative solutions and technologies. Industrial Automation will share space with four additional shows from Germany's Hannover Messe, providing an exceptional opportunity for business development. The fact that it's situated alongside IMTS, North America's leading manufacturing technology trade show, only provides more incentive to get involved.

Highlights from 2014. Industrial Automation—along with accompanying event Motion, Drive & Automation—boasted impressive numbers and helped IMTS grow by 13.9% from 2012:

- 194 exhibitors (IMTS total: 2,035)
- 12,000 visitors (IMTS total: 114,147)
- 4,650 sqm (IMTS total: 120,000 sqm)
- 112 countries represented

Why Attend? Industrial Automation North America (IANA)—together with IMTS—is the most comprehensive manufacturing technology trade show in the Western Hemisphere. Bringing together a diverse and comprehensive group of industrial automation companies, you will surely find technologies and solutions to meet your manufacturing needs. Network with key industry players and learn from industry experts through the Industrial Automation North America conferences and training workshops.

***Visit Industrial Automation North America to*:**

- Find the latest solutions and innovations in manufacturing technology
- Meet face-to-face with key suppliers from around the world
- Discover new technology solutions
- Strengthen you international business network
- Prepare and finalize your purchase decisions

Product Categories

Automation Technology

- Robotics & systems integration
- Image processing
- Assembly & handling systems
- Identification
- Lasers
- Latches, locking systems + operating elements
- Mechanical / plant engineering
- Pick-and-place
- Linear drives
- Mobile robots
- Application park robotics, automation & vision

Production Automation

- Electric power transmission/motion control
- Pneumatic systems
- Production logistics and materials handling systems
- Pumps & pump systems
- Vibration measurement systems
- Energy efficiency

- Automation forum

Process & Energy Automation

- Solutions for automation and energy engineering
- Process automation systems
- Process control systems
- Instrumentation (measurement and control)
- Process analysis technology
- Connection / interface technology
- Industrial building automation
- Engineering, maintenance, services

Automation Technology & IT

- Industry 4.0
- Wireless, M2M & Internet of Things
- Virtual reality
- Additive manufacturing
- SmartFactoryKL
- Product and trademark protection
- Smart Connected
- IT security
- Cyber physical systems
- Control systems
- IPCs / SPS
- Sensor technology, instrumentation
- Image-processing sensors
- Security technology
- Connection / interface technology

For more information: Contact Bill Fox at *bfox@hfusa.com*, or +1 (773) 796-4250

The Show: Motion, Drive & Automation North America at IMTS

Motion, Drive & Automation North America (MDA) returns as a co-located event with IMTS 2016, showcasing the latest technologies and solutions in power transmission, motion control and fluid technology. Motion, Drive & Automation—along with four additional trade shows from Germany's Hannover Messe—provides an outstanding business development platform. Just as Industrial Automation North America (IANA) distinguished itself as an industry-leading event, so too is Motion, Drive & Automation North America poised to become a key business opportunity and networking hub for its sectors.

Highlights from 2014. Motion, Drive & Automation, along with accompanying event Industrial Automation, boasted impressive numbers and helped IMTS grow by 13.9% from 2012:

- 194 exhibitors (IMTS total: 2,035)
- 12,000 visitors (IMTS total: 114,147)
- 4,650 sqm (IMTS total: 120,000 sqm)
- 112 countries represented

Why Attend? Motion, Drive & Automation North America, Industrial Automation North America and IMTS have combined to create the most comprehensive manufacturing technology trade show in the Western Hemisphere. The 2014 launch of Motion, Drive & Automation North America further expanded the range of technologies and solutions presented at IMTS by bringing the power transmission, motion control and fluid technology sectors together.

Visit Motion, Drive & Automation North America to:

- Find the latest solutions and innovations in manufacturing technology
- Meet face-to-face with key suppliers from around the world
- Discover new technology solutions
- Strengthen your international business network
- Prepare and finalize your purchase decisions

Product Categories

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- Seals

For more information: Contact Aryan Zandieh at *azandieh@hfusa.com,* or +1 (312) 805-8740

MDA, IANA and IMTS 2016

The following exhibitors are suppliers of products or services that may be of interest to readers of *Power Transmission Engineering*. The Booth numbers include a letter indicating the building location (N=North, S=South, E=East, W=West, C=North Building, Hall C).

Exhibitor	Booth	Booth Preview	Ad
Advanced Machine & Engineering	W-2405, NC-421		
Aerotech	N-6442		
AMETEK	E-5642		
ANCA Motion	E-4263, N-7414	46	
Andantex USA Inc. / REDEX / WMH Herion	N-6031		19
Atlanta Drive Systems, Inc.	E-4829		
Austin Engineering Co. - AEC Bearings	E-5162		
B&R Industrial Automation	E-4115	48	
Bajrang Engineering Works	E-4726		
Balluff Inc.	E-4057	46	
Beckhoff Automation	E-4410		
Bimba Manufacturing	E-4821		
Boca Bearing Company	NC-142		
Bosch Rexroth Corporation	E-4854	50	
CGI Inc.	E-4857		
Cheng Dai Co., Ltd.	E-5192		
Chieftek Precision	E-4738		
Comintec	E-5265	44	
Cone Drive	E-4997		
Dalian Huayang Jinggong Bearing Manufacturing Co., Ltd.	E-5172		
DKM Motor Co.	NC-452		
Dontyne Gears	N-7227		
Dreisilker Electric Motors, Inc.	NC-335		
Dynatect Manufacturing, Inc.	NC-300		
Elmo Motion Control	E-4557		
Essentra Components	NC-763		
ETP Transmission AB	N-6197		
EZO SPB-USA PRECISION BALL BEARINGS JAPAN	E-4725		
Fagor Automation	E-5237, S-8790		
Festo Corp	E-5066, NC-529		
Flair Industry Accessory Co., Ltd.	W-1273		
Framo Morat	E-4647	44	
Gleason	N-7000		
Global Machine Parts	NC-167		
GMN USA	N-7151		
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Ningbo Fulong Synchronous Belt	E-4890		
Nippon Pulse America	E-4723		
Nook Industries, Inc.	E-4065		
NRB Industrial Bearings	E-5080		
NSK Americas	E-4733		
Opto 22	E-4166		
Oriental Motors	NC-367		
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Paletti USA	NC-638		
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Rockwell Automation	E-4357		
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URB Group	N-6388		
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MDA NORTH AMERICA

Industrial Automation NORTH AMERICA

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Exhibitor	Booth	Booth Preview	Ad
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Hoover Precision Products, Inc.	NC-161		
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IMTS 2016 Booth Preview

Mechanical Motion Front and Center at MDA, IANA and IMTS

IMTS has expanded its range of manufacturing services with the addition of Motion, Drive and Automation (MDA) and Industrial Automation North America (IANA). These co-located shows complement the metalworking solutions found at IMTS by bringing in key suppliers from around the world.

Motion, Drive & Automation North America

This event will feature technologies and solutions for the power transmission, motion control and fluid technology sectors together. Meet face-to-face with key suppliers from around the world and see first-hand the best new technology available. Here are some highlights:

ComInTec

BOOTH E-5265

Originally founded in 1967 by Dante Cavalli, under the name OMC Snc, the company originally manufactured mechanical transmission components. Then, in 2010, the company changed its name to ComInTec and began exploiting its experience and know-how to offer high quality solutions through the specialized design and manufacture of: power transmission components, torque limiters, safety couplings, backlash free torque limiters, elastic couplings, disc couplings, backlash free couplings, variable speed pulleys, expanding pulleys, shaft collars and clamp collars. ComInTec manufactures special components that play a vital role in the production of automatic and mechanical transmission machines. These components create transmission connections, avoid accidental overloads, reduce machine stoppage times, increase productivity, and reduce maintenance and repair costs.

For more information:
ComInTec
Phone: +39 051 780216
www.comintec.com

Framo Morat, Inc.

BOOTH: E-4647

Framo Morat, Inc. will be presenting its diverse product range at IMTS 2016 for the first time. Since the founding of Franz Morat GmbH in 1912, gear and drive engineering has been in a continuous state of development at the company's headquarters in Eisenbach, Germany. With subsidiaries in the United States, the Netherlands, Poland, Mexico and Turkey, as well as a worldwide network of sales partners, Framo Morat is a globally operating manufacturer of high-quality drive solutions for many industries. Framo Morat is among the leading manufacturers in Europe, particularly in the area of worm gear sets and its plastic group F. Morat in molding the material PEEK.

Framo Morat specializes in custom drive solutions with drives that are designed and developed specifically for the customer's requirements. With years of experience, Framo Morat is the ideal partner for every phase of a project, from developing specifications, through development and design, to prototype construction, testing, assembly and regular production. Currently, the company offers sales support and repair services at its Albuquerque, NM office.

In addition to its custom drive solutions for various industries, Framo Morat also focuses on numerous successfully implemented solutions like gears or plastic injection molded parts. In addition, the company presents its two new planetary gearbox series, which are characterized by smooth operation, high torsional rigidity, long life, high power density, variety of gear ratios as well as quality "Made in Germany."

For more information:
Framo Morat Inc.
Phone: (505) 359-2949
www.framo-morat.com

R+W Coupling Technology

BOOTH E-4894

In an effort to address increased demand for its SERVOMAX elastomer couplings in high speed spindle applications, R+W Coupling Technology will be showcasing a new ultra-precision model, SP6, at this year's MDA pavilion at IMTS. Made with improved concentricity and perpendicularity, and higher grade materials, the hubs are capable of handling circumferential speeds of up to 80 m/s, and higher torque levels per size. The SP series also has an increased bore diameter capacity per body size, and adjustable positioning of the outer clamping ring, allowing users to fine tune the location during installation. With a choice of high strength aluminum or steel, the SP6 is available in 4 body sizes, with bore diameters ranging from 14 to 55 mm, torque ratings from 60 to 1350 Nm, and standard "off the shelf" speed

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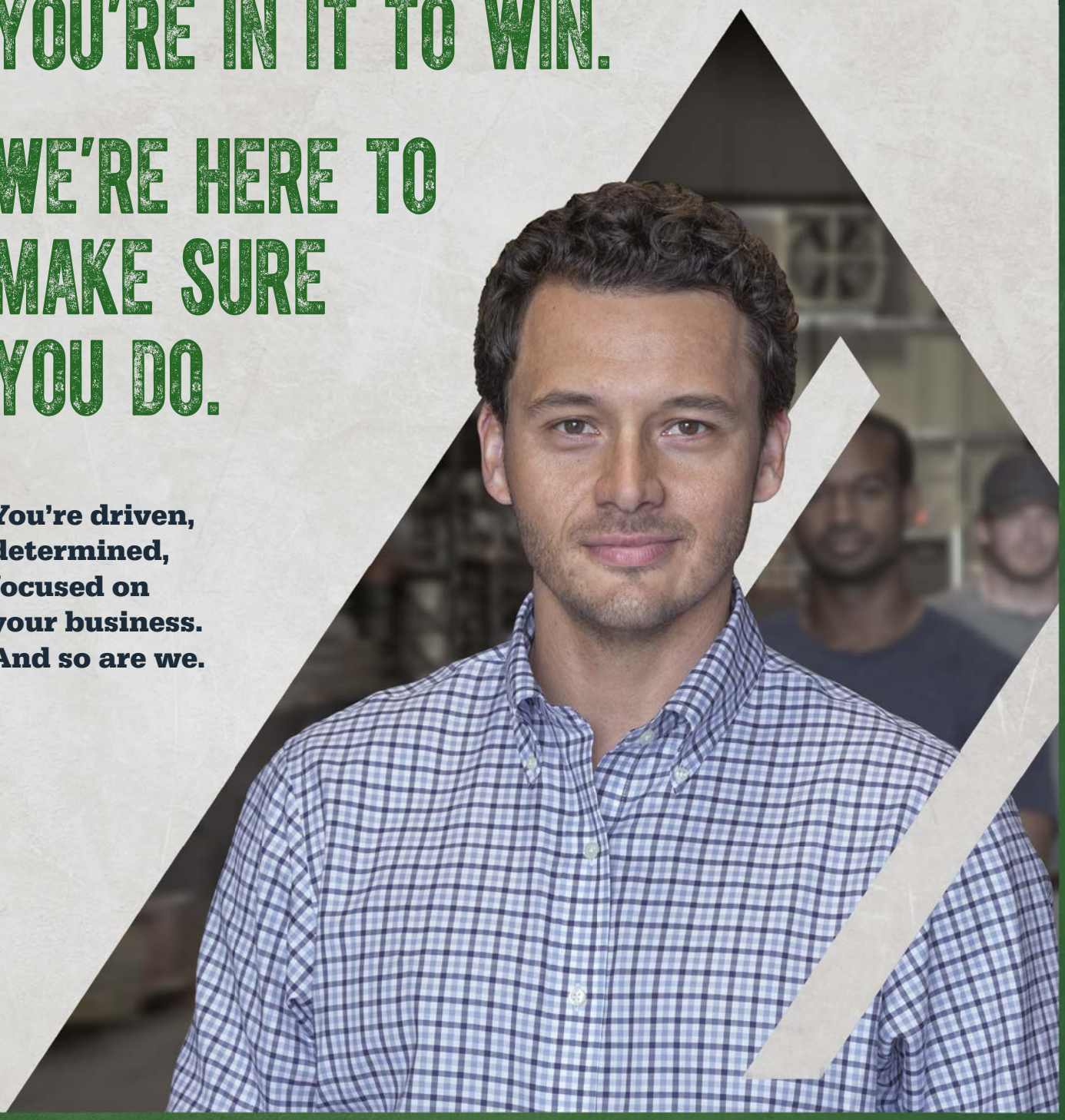

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For more information:
R+W America
Phone: (630) 521-9911
www.rw-america.com

Industrial Automation North America

IANA made its North American debut in 2012 co-located with IMTS. Featuring factory, process, and building automation, this event is distinguishing itself as the place to see the automation industry's most innovative solutions and technologies. Here are some highlights:

ANCA Motion

BOOTH E-4263, N-7414

ANCA Motion's innovative LinX Linear Motor provides improved performance at lower cost with excellent efficiency when compared to ball screws and flatbed linear motors. The standalone thermal stability, high speed and acceleration, zero down forces and the ability to achieve IP69K protection make the LinX suitable for the machine tools and general automation industries.

Benefits over flatbed linear motors include standalone thermal stability (the LinX doesn't need a dedicated chiller which greatly reduces the machine size and power consumption as well as floor space required), higher efficiency thanks to its tubular design, no cogging, IP67/IP69K protection for food packaging and pharma applications, and LinX's cylindrical form factor makes it ideal for retrofitting ballscrews and pneumatic and hydraulic cylinders. Benefits over ballscrews include direct drive, no wear, no loss of preload, easier alignment, higher acceleration and faster speed as well as an improved surface finish.

"ANCA Motion's patent pending thermal barrier technology ensures unprecedented stand-alone thermal stability performance which can greatly improve machine's performance and reduce power consumption and floor space," said Lucas Hale, global marketing manager. "One big problem with the flatbed linear motor is the heat source in contact with machine's bed which affects the accuracy of the machine. Machines using flatbed linear motors typically require a dedicated chiller to cool the motors which consumes more power and takes more space."

For the LinX Linear Motor on the other hand, there is no touch between its heat source (forcer) and machine bed. "With the LinX's unique thermal barrier technology specifically designed for fluid cooling, the heat can be completely removed from the machine. Therefore, the accuracy issue associated with a machine's thermal growth is eradicated, and due to its higher efficiency and mechanical form factor, the LinX can use a machine's existing cooling system which reduced power consumption and floor space," Hale added.

LinX motors have been used in ANCA's FX and MX grinding machines. After the launch of FX Linear and MX Linear machines, LinX powered machines have been installed at various regions all around the world. "We are bringing the inverted pendulum demonstration rig to IMTS to showcase the LinX Linear Motor's unique features and state-of-the-art technology. The pendulum is mounted on the cylindrical LinX motor which moves along a magnetic shaft, housed in a stainless steel tube. In order to maintain the pendulum's balance, the motor must respond promptly and precisely to the disturbances. The LinX Linear motor provides a perfect solution for this thanks to its high speed, high acceleration, zero-backlash and low cogging features, all of which are a result of the unique cylindrical design. Combined with ANCA Motion's control system, the LinX Linear Motor can significantly improve a machine's performance." Hale said.

For more information:
ANCA Motion
Phone: +61 3 9751 8900
www.ancamotion.com

Balluff Inc.

BOOTH E-4057

Balluff has more than 50 years of sensor experience providing integration services, application support and training. During the IANA show at IMTS, Balluff will be displaying a variety of products and technologies including a new industrial automation network, power supplies, network weldblocks and an expanded inductive coupling family.

CC-Link IE Field Machine Mount I/O Blocks

Balluff's new family of network solutions is based on the industry's newest and fastest industrial Ethernet network – CC-Link IE Field. "CC-Link IE (a gigabit network for industrial automation) realizes the next generation of industrial applications that require large bandwidth for data without compro-

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mising deterministic performance. We are proud to be the first in the industry to offer CLPA conformance tested and approved CC-Link IE Field network I/O modules," states Tom Rosenberg, director of marketing at Balluff Inc. "CC-Link IE Field modules enable our customers to utilize the benefits of distributed modular architecture in applications that were not possible before."

Balluff's CC-Link IE network portfolio consists of IP67 protection rated machine mount I/O devices and IO-Link masters. The distributed modular architecture utilizes IO-Link to enhance the controls architecture in a cost effective manner while integrating smart devices into the architecture. IO-Link is the first sensor-actuator communication standard specified in IEC61131-9 and utilizes standard M12 sensor cables for communication of process data, parameter data, and events on the same line. With the addition of CC-Link IE into Balluff's networking suite, Balluff can now offer its customers the same architectural scalability with CC-Link IE that it has been offering for other networks including EtherNet/IP, PROFINET, EtherCAT, DeviceNet, PROFIBUS, and CC-Link.

New IO-Link Power Supplies

Power supplies are key components in automation but can easily be overlooked or last on the agenda. When a power supply fails, the sensors, actuators and the controller all come to a halt to figure out which part of the system has failed. It is up to the controller to figure out which part caused the halt in production. The power supply is often replaced long before it is necessary to prevent the risk of automation component failure, which ultimately leads to loss of productivity.

Balluff offers a full line of power supplies, which now includes IO-Link versions with the Heartbeat function. The Heartbeat function consists of a stress level indicator, load level indicator and life expectancy indicator, which lets the user visually know how the power supply is doing and when a power supply would need to be replaced. Ultimately this will allow the full life of the power supply, years longer than the standard replacement time.

These three indicators help operators to use the power supply within an optimal range. The IO-Link function enables getting information parameters to the control system in the least costly manner. The control system can then alert operators for counter actions to prolong the use of the power supply to the maximum possible life. In this manner, IO-Link assures continuous condition monitoring of the system.

Network I/O Weldblocks

Balluff recently announced an entire new family of network I/O blocks optimized for extremely noisy electrical environments, such as welding. These new Balluff Weldblocks are constructed with fiberglass reinforced composite (polypropylene sulfide) that inherently resists weld spatter while effectively combats grounding loops and electromagnetic interference (EMI). "Balluff Weldblocks offer an ideal solution for our customers needing to fight the high electrical noise in their welding applications while keeping their controls cabinets lean," said Rosenberg. "With IO-Link on board, Weldblock IO-Link masters and I/O hubs can build entire controls architecture around the weld cell that was previously a challenge."

Bi-Directional Inductive Coupler

Balluff has expanded its IO-Link enabled Inductive Coupling product family to include bi-directional IO-Link communication. The Balluff inductive coupling solution enables transfer of power and data over a small air gap - making it ideally suited in the industrial space, where getting I/O in hard to reach places or moving components is a challenge. The Balluff IO-Link inductive coupler, with its small compact IP67 housing (40 mm × 40 mm × 70 mm), is the industry's first compact inductive coupler to offer 32 bytes of bi-directional data transfer over a standard 4-pole M12 sensor cable. It's also rated for 500 mA at a five mm gap with 24 V power.

"IO-Link enabled inductive couplers uniquely combines two of Balluff's product portfolios – the IO-Link family and the inductive coupling family – to tremendously simplify today's complex automation needs in robotics applications, assembly line automation, turntable-based systems, and even press automation," says Shishir Rege, marketing manager for networking products at Balluff Inc.

For more information:
Balluff Inc.
Phone: (800) 543-8390
www.balluff.com

B&R Industrial Automation Corp.

BOOTH E-4115

B&R Industrial Automation Corp. specializes in standards-based, scalable and modular control systems integrating CNC, logic, general motion, robotics, human-machine interface (HMI), safety, I/O and data acquisition in a unified software development environment.

Benefits of integrated control

The efficiency of CNC machine control development and operation can be improved by replacing traditional systems with an integrated, multifunctional control platform. Traditional systems include logic, machine-specific technologies, point-to-point movement, path-based interpolated movement and visualization each requiring hardware interface and communication software to work together.

With B&R's integrated solutions, a single software development environment, Automation Studio, running under the same hard real-time operating system on a single processor over deterministic industrial Ethernet, unifies all these functionalities. The straightforward, standards-based design approach lets OEMs easily and independently implement machine processes on the controller without need for intervention by the control supplier. This benefits both machine builders and users by streamlining engineering, hardware, training and service costs while delivering uncompromising performance, flexibility and scalability. As a result, machine builders can respond to customers' needs more rapidly while maintaining the integrity of their intellectual property.

Scalable CNC and robotic control

The solution is completely scalable with all motion control technology, including, but not limited to, hydraulics, steppers, servos, linear and rotary actuators, and pneumatics. It integrates seamlessly into the machine application, allowing it to be customized for the specific task at hand. The flexible design also makes it simple to integrate robotic control with CNC. Kinematics for various types of robotic control — such as SCARA, delta, articulated, portal and gantry — are supported. The onboard control also eliminates the need for additional PLCs to perform auxiliary functions such as infeeds, outfeeds, conveyance, stackers and de-stackers.

Some highlights at the IMTS B&R booth include:

The introduction of an advanced linear track conveyance system that complements B&R's automation competencies. The intelligent transport technology combines optimized productivity and flexibility with industrial-grade reliability to ensure maximum uptime.

IMTS attendees can also discover the world's first field device for OPC UA. The new X20 I/O system bus controller makes it possible to implement OPC UA communication from the sensor layer to the ERP layer without any interfaces whatsoever.

B&R has further expanded its portfolio of modular mapp software components. IMTS attendees will also be introduced to the new mapp RoboX and mapp Teach that make it faster and easier than ever to get robotic systems configured and ready for operation.

IMTS attendees will also learn about HTML5 based HMI development using the new mapp View. For the first time, automation engineers have all the tools they need to create powerful and intuitive web-based HMI solutions – without the need to learn HTML5, CSS and JavaScript.

IMTS attendees will also learn more about the *SafeDESIGNER* library for press applications. B&R is one of the first manufacturers to offer a complete set of the function blocks specified in PLC open part 4. As a result, users working with safety-critical press applications will have a much easier time setting up the necessary safety functions.

For more information:
B&R Industrial Automation Corp.
Phone: (770) 772-0400
www.br-automation.com

Mitsubishi Electric Automation

BOOTH E-4102

The Mitsubishi Electric Automation booth will feature the M8 Series CNC Controls, with gesture smartphone-like features, and e-F@ctory enterprise connectivity solutions. The M8 Series control platform is designed to address the need for a fast, precise and affordable computerized numerical control (CNC) system for complex machining applications. The M800 is a high-grade CNC designed for high-speed, high-accuracy machining and multi-axis, multi-part system control and features the industry's fastest CNC, while the M80 provides high productivity and easy operability. Both offer a 19" capacitive touch screens with icon-based navigation for easy, intuitive, smartphone-like operation, with the ability to add screen customization.

With e-F@ctory, all business stakeholders, from the factory floor and operations to the C-Level, have access to the data they need to make smart business decisions. This provides connectivity to manufacturing assets by leveraging open Ethernet protocols such as CC-Link IE, and open communication standards such as MTConnect and OPC. This connectivity allows broad access to Mitsubishi Electric controls used in operational technology applications such as MC Works64 visualization, AX Facility, and AX Energy analytics to improve operational efficiencies. This facilitates IT application integration supporting on-premises

and cloud-connected infrastructures.

The company's product portfolio of programmable logic controllers (PLC), human machine interfaces (HMI), inverters (VFD), servo amplifiers and motors, control software, computerized numerical control (CNC), circuit breakers, robots, motion controllers, and power monitoring and energy management products, provide a complete solution for customers.

For more information:
Mitsubishi Electric Automation, Inc.
Phone: (847) 478-2100
http://us.mitsubishielectric.com/fa/en

IMTS

The following booths will be of interest to Power Transmission Engineering readers that are not part of the MDA or IANA co-located programs:

Bosch Rexroth

BOOTH E-4854

Rexroth is bringing their latest advancements to the Windy City. The automation engineering leader will showcase its new IMS-A integrated measuring system and the latest version of their IndraMotion MTX CNC solution at the International Manufacturing Technology Show in Chicago. Both innovations help to continue paving the way for Industry 4.0 integration in the medical industry.

IMS-A: A glass-accurate guide and measuring system in one: The new IMS-A integrated measuring system blends accurate measurement with robust performance in machining, 3-D printing and medical manufacturing of tubing, surgical and dental tools, electronics and implants. It detects the absolute position of the axis to ±4 micrometers. What's more, the measuring system is immune to contamination, vibrations, shocks and magnetic interference, and needs no buffer batteries in the event of a power failure. Thanks to the complete integration of the sensor and evaluation electronics in the ball and roller runner blocks, design engineers can avoid external measurement and air purge systems.

Always 'On' point: Turning machines back on again following a power failure can result in a critical situation. That's because the controller in many applications needs to know the position of each axis immediately. Purely incremental measuring systems need to first complete a reference run for this, which extends the ramp-up time and, in a loaded state, can result in damage to the workpieces and tools. The new integrated IMS-A measuring system from Rexroth immediately recognizes the absolute position of the axis with a high degree of precision when the machine is switched on and reports them to the controller without carrying out a reference run. This also eliminates the need for buffer batteries that have to be replaced.

Inductive and wear free: Thanks to the inductive measuring principle, the IMS-A operates without physical contact and is therefore a wear-free assembly. The measuring scale cannot be interfered with or destroyed by external magnetic fields. The IMS-A is not sensitive to vibrations up to 10 G and shocks up to 50 G. The sensors and evaluation electronics are located in the protective housing on the end face of the runner block. Even in working spaces with coolants, dust, shavings and other contaminants, the IMS-A does not require elaborate energy-eating, high-maintenance air purge systems. Even electrical and magnetic interference fields do not affect the measurement results.

Integrated Functions: The functional integration of guiding and measuring in an assembly minimizes installation times. No adjustment of the measuring system is necessary. With the IMS-A, engineers can use several runner blocks on an up to 4,500 mm long profile rail independently and without any accuracy limitations. All components, are replaceable in the event of servicing, which reduces costs. The interchangeable construction offered by Rexroth ensures even less effort. All runner blocks of the same size fit onto the profile rails of the respective size without any restrictions. The measuring system transmits the data via HIPERFACE interfaces, as well as via SSI/1Vp-p to the intelligent drives or controller, DRIVE-CLIQ and FANUC interfaces are to follow.

Prepared for Industry 4.0: The integration of additional temperature and motion sensors makes this measuring system prepared for the future requirements of Industry 4.0. The additional sensors allow machine designers, for example, to read out the temperature and the actual dynamics. The sensor data also forms the basis for future approaches to predictive maintenance. The user can record and evaluate operating states online. If the accelerometers detect changes, such as increasing vibrations, then this is an indication of wear or other problems. Scheduled maintenance can then intervene before the machine needs to be shut down.

IndraMotion MTX: Full power from compact to 250 axes: With the latest versions of the IndraMotion MTX CNC system family, Bosch Rexroth offers significant increases in performance and, thanks to additional software functions, productivity. These versions also shorten cycle times across the whole spectrum of machine tools. In the highest configuration, IndraMotion MTX now controls up to 250 axes in 60 independent NC channels using one control hardware. The system solutions are already designed for the requirements of industry 4.0 with open interfaces to the IT world, multi-touch operating devices and simulation programs.

Automate complicated systems economically: By means of a multicore processor, the system solution achieves minimal cycle times even with a maximum number of axes and replaces additional controls that were previously necessary in complex rotary transfer machines. Thanks to this, machine manufacturers can also economically automate complicated systems, especially since a PLC in accordance with IEC 61131-3 is integrated for automation in all variants. With

pre-defined technology functions for turning, milling, drilling, grinding, punching and jet cutting, the system solution is suitable for universal use and has been proven for medical applications such as making dental brace components.

Simulation for shorter cycle times: With its scalable simulation software, Rexroth provides the opportunity to test and optimize NC programs at different complexity levels, both online and offline. This software monitors collisions and offers extensive opportunities to optimize NC programs in order to reduce cycle times with higher cutting force and shorter downtimes.

Ready for Industry 4.0: The IndraMotion MTX system family already fulfills all of the prerequisites for horizontal and vertical networking with an integrated OPC UA webserver and the Open Core Interface technology.

For more information:

Bosch Rexroth
Phone: (800) 739-7684
www.boschrexroth-us.com

Heidenhain Corp.

BOOTH E-5226

Heidenhain will present its precision measurement components and systems at IMTS 2016 as well as highlights from two of its many internationally-owned entities: ETEL and Acu-Rite brands. Heidenhain North America represents and distributes seven precision measurement component company brands.

This year's 50×60-foot IMTS Heidenhain booth will be host to many of the industry's very latest motion control options including a brand new Quadra-Chek 3000 digital readout, Heidenhain encoders (including the RCN 6000 angle encoder and LC 100 linear scale) and unique TNC control/capabilities. ETEL's TMB+ torque motors, as well as the Acu-Rite MILLPWRG2 CNC control with enhanced features will also be shown.

Heidenhain's new Quadra-Chek 3000 is designed for measuring 2D geometrical features quickly and easily, utilizing technology that, up to this point, has only been available on PC systems. ETEL's new TMB+ torque motors improves upon the well-known TMB series with even greater material quality, new size additions (62 sizes up from 50), higher force density and more winding options. These motors can achieve peak torque values up to 44,000 Nm.

Acu-Rite's MILLPWRG2 CNC Control is for vertical knee and bed mills. It is available with an optional AMI (auxiliary machine interface) and spindle control console offering users the ability to use common interfaces as well as control its host machine tool's spindle.

A presentation on advanced TNC control capabilities by Heidenhain is also in development for delivery at the booth. More information on this and other product information will be released at show time.

For more information:

Heidenhain Corporation
Phone: (847) 490-1191
www.heidenhain.us

J.W. Winco, Inc.

BOOTH N-6586

J.W. Winco, Inc., a supplier of standard industrial machine components, will feature the GN 810 Vertical Acting Toggle Clamp with Universal Fit Horizontal Base that accommodates inch/metric mounting hole patterns during IMTS 2016. The RoHS-compliant toggle clamp, with a hold-down bar and handle that move in the same direction, is made from case-hardened sheet metal (C10 steel), zinc plated, with a blue passivated finish. The bearing pins are tempered, the hand grip is high quality, oil resistant red plastic, and all moving parts are lubricated with special grease. The neoprene spindle assembly has a threaded stud made from steel, zinc plated, blue passivated finish, while the spindle tip is black neoprene rubber, 85° shore A and vulcanized.

The vertical acting toggle clamps in the U-bar version have two flanged washers that can accommodate an application specific clamping screw. The Type E version can either be utilized by welding the clasp, which can then accommodate an application specific hold-down fastener component, or by utilizing the bar in conjunction with Winco's GN 809 Clamp Mounts to hold the workpiece in place.

For more information:

J.W. Winco, Inc.
Phone: (800) 877-8351
www.jwwinco.com

SKF USA Inc.

BOOTH NC-220

The new SKF Shaft Alignment Tool TKSA 51 performs with a dedicated and easily downloaded app to enable precise alignment of shafts in rotating machinery across industries. The tool – the first instrument of its kind designed for intuitive shaft alignments using tablets and smartphones – makes it quick and easy to set up motors, drives, fans, gearboxes, pulleys and couplings, regardless of an operator's level of experience.

The TKSA 51 consists of two compact and lightweight laser measuring units and shaft brackets to mount the tool, whether on small machines with limited space or on larger equipment using supplied extension chains and magnetic holders.

With the tool mounted, the wirelessly connected TKSA 51 app uses real-time data to provide a live 3D view of the measuring units, allowing operators to rotate the virtual machine at will and in all directions to achieve a highly intuitive alignment process. Measurements at any angle can be made by a touch of a button or by using the system's hands-free automatic measurement function, which only requires the shaft to be rotated to the next measurement position. Among other user-friendly features, notification and helpful guidance menus are displayed to assist operators during setup and use.

Upon completion of an alignment check or correction, a comprehensive report is created for customizing, emailing, or uploading for future reference or trending. The SKF Shaft Alignment Tool TKSA 51 serves as a comprehensive system for all alignment tasks and joins a growing portfolio of unique SKF technology solutions to promote optimized machinery health, reliability, and productivity.

In addition, SKF will be discussing SKF Enlight, a mobile and cloud-based system that helps operators document and manage wind turbine operation and maintenance tasks. With SKF Enlight, operators use the DataCollect app by SKF to collect turbine inspection data with any smart device, and then upload it to the SKF Cloud for 24/7 access and analysis. By helping operators improve inspections, make better maintenance decisions and cut costs, SKF Enlight supports SKF Life Cycle Management, a proven approach that can add value throughout the turbine life cycle.

For more information:
SKF Industry Inc.
Phone: (800) 440-4753
www.skfusa.com

Siemens Industry, Inc.

BOOTH E-4502

Here's what's happening at Siemens booth during IMTS: The new SINUMERIK 808D/828D/840D has been updated and features new CNC multitouch panel hardware along with new software functions that bring machine tool users a greater return on CNC. Siemens Smart Operation presents a future-oriented portfolio for efficient working processes on the SINUMERIK CNC control. By using smart operation, shop floor-oriented companies can make the first steps towards digitalization and increase their productivity. The booth will also include demonstrations of a machining application controlled by the SINUMERIK 840D sl CNC . In addition, the Siemens Lifelong Educational Advantage Program gives tech school graduates a career-enabling machine tool foundation for the manufacturing jobs of tomorrow.

Product Highlights at the Siemens booth include the company's Generation II Simotics 1FK7 servomotors and its Sinamics S120 drive system.

Highly-configurable to suit a wide variety of applications, the Generation II Simotics 1FK7 servomotors features seven shaft heights, a Quick-Connect power connector and high-accuracy 20- and 24-bit field replaceable encoders in 10 styles.

The Generation II servomotor offers three inertia versions — standard, high-dynamic for rapid acceleration jobs, and high-inertia for maximum smooth running. These motors are designed for operation without external cooling and the heat is dissipated through the motor surface.

With 10 styles of field-replaceable encoders, the 1FK7 Generation II servomotors provide easy maintenance in the field, with reduced downtime and operating cost savings. Further, a 10 percent improvement in continuous (S-1) power is achieved since the encoders are mechanically and thermally decoupled from the motor. The mechanical decoupling also means the encoder is more resistant to vibration conditions on the machine. In addition, there is no need for battery backup on the absolute encoders.

The Sinamics S120 drive system now offers an integrated web server to facilitate more efficient diagnostic and maintenance functionality for end-users, integrators and system designers alike. With this drive improvement, a user may access the Sinamics S120 with any PC with a browser capable of internet connectivity through a standard Ethernet interface to execute a variety of functions. If a wireless LAN (WLAN) router is networked, web pages can be viewed using other web-capable devices such as tablets and smart phones.

Among the functions possible with this integrated web server on Sinamics S120 drive systems is the ability to download a plant configuration, commission a drive from anywhere, perform firmware updates, access an immediate status overview on the drive, check and assess all alarm and fault messages.

In addition, users can monitor and adapt all process or line parameter settings, archive machine documentation including all notes taken, create customized server pages, set-up user administration and access level for operator and service personnel, plus perform virtually all drive diagnostics and remote maintenance actions. This combination of service possibilities results in significant reductions in machine or line downtimes, due to faster, more efficient diagnostic and maintenance procedures.

For more information:
Siemens Industry, Inc.
Phone: (847) 640-1595
www.usa.siemens.com

Steinmeyer Inc.

BOOTH NC-467

Steinmeyer, a manufacturer of precision ground ball screws, announces its participation in the 2016 International Manufacturing Technology Show, Booth NC-467at McCormick Place in Chicago, from September 12–17. Company executives and engineers will be on-hand to discuss Steinmeyer's large portfolio of ball screws, including: miniature ball screws, precision ball screws, ultra-thrust ball screws and rotating nuts. If attendees have a specific design project that they would like to discuss with Steinmeyer engineers, contact the company below to book a personal appointment.

For more information:
Steinmeyer Inc.
Phone: (781) 273-6220
www.steinmeyer.com

Yaskawa America, Inc.

BOOTH E-4154, NC-533, N-6600

Yaskawa and Clearpath have partnered to develop a mobile machine tending and material movement solution ideal for shop floor environments. This fully integrated solution will feature a Motoman MH12 robot equipped with end-of-arm tool and vision system, mounted on Clearpath's OTTO 1500 self-driving vehicle. This project is currently under development and supported under the advanced research division of Clearpath.

"Our partnership with Clearpath will provide industry with a robust, tightly integrated solution for moving robots to the work in a very flexible and dynamic way," said Roger Christian, divisional leader, new product development at Yaskawa Motoman. "This autonomous modular solution provides users an alternative to arranging the work to a fixed robot station."

The MH12 robot features a 12 kg payload capacity, hollow wrist for reliable EOAT cable management and a 1,440 mm horizontal reach. Its versatile design provides higher speed, longer reach and increased payload over current mobile manipulator products offered by competitors.

The OTTO 1500 offers a payload capacity of 3,300 lbs. and is built with industrial grade components to withstand the rigors of industrial environments. It is designed to increase throughput, reduce operating costs and remain flexible with the changing needs of material flow processes.

"We're really excited to partner with Yaskawa to develop the future of mobile manipulation and collaborative robots," said Matt Rendall, chief executive officer at Clearpath. "Combining our cutting-edge self-driving industrial vehicles with Yaskawa's industry-leading robot arms will enable a new category of automation for machine tending."

Yaskawa will have information on low and medium voltage AC inverter drives, servo drives, machine controllers and industrial robots during IMTS 2016.

For more information:
Yaskawa America, Inc.
Phone: (937) 847-6200
www.yaskawa.com

Worm Gear Cutting

THE QUESTION

I have a fairly straightforward question about a worm gear segment. But as of yet, I haven't gotten a straight answer from any of the gear job shops I've approached about this job. Is there a "traditional" gear cutting method that can produce a ~180 degree enveloping worm gear segment when a feature on the back of the part will interfere with a complete rotation of the part?

Or am I left with only the option of 4- or 5-axis surfacing with a CNC mill?

I have presented this part to several well-known gear shops in the U.S. without a straight answer on how the part can be made.

Any help you could offer would be appreciated.

Expert Response Provided by Ernie Reiter P. Eng., President, Web Gear Services Ltd.:

The question relates to the manufacturing of a sector worm wheel which has teeth covering 180 degrees of rotation. To further clarify the question, the worm wheel also has its body extending away from the center of rotation in a manner shown in the attached figure.

Aside from CNC machining, which requires the complexity of an accurate 3-D model to create the surface profiles, the most common method of manufacturing worm gears is by hobbing, using a cutter (mounted at 90 degrees to the axis of rotation) whose profile is nearly similar to the mating worm that will mesh with the worm wheel.

Hobbing is the predominant manufacturing method since most worm gears are made of softer materials which rarely exceed 30 HRC. Materials with hardness of up to 37 HRC can be hobbed; however some manufacturers are reluctant to do it due to the increased tool wear and slow cutting speeds. Ultimately these issues are cost related. Some manufacturers may or may not be interested in taking on this higher level of hardness. Grinding of worm gear teeth is not commonly done.

The issue of finding a supplier with the capability to hob the required gear with 180 degrees of rotation is dependent on the specific machine, the cutting tool shank and mounting on the machine, and the part design itself. It may be that the combination of these issues for your specific part severely narrows the field of suppliers that are able to produce your part. Figure 1 shows the interference zone where these issues converge.

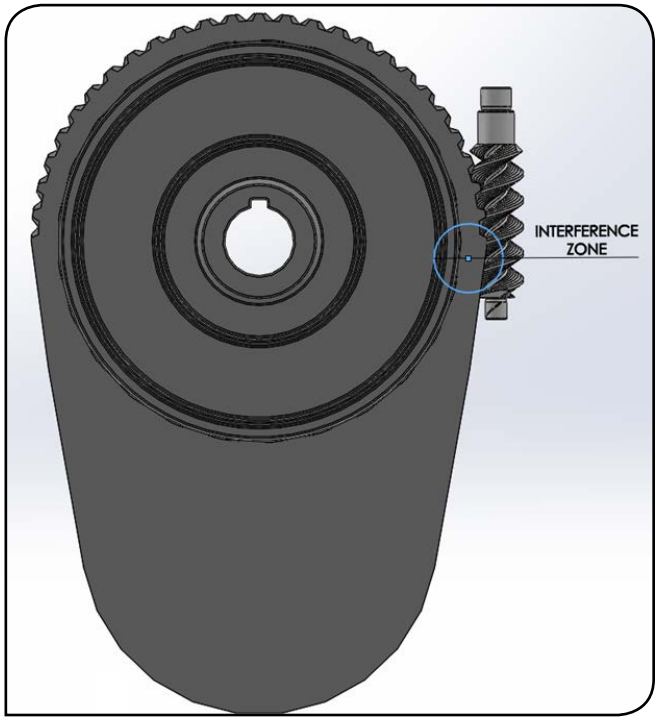

Figure 1 It may be that a combination of issues for your specific part severely narrows the field of suppliers that are able to produce it. Shown is the interference zone where these issues typically converge (Image courtesy Web Gear Services Ltd.).

Some design changes that may increase the manufacturing capability include modification of the extension feature of the sector gear to allow more clearance for the cutter without contacting the part; reduction of the sector to less than 180 degrees; or modification of the design to a crossed axis helical gear instead of a worm gear — which may allow for more cutting tool options to provide clearance — including using a hob tilted off 90 degrees to the axis of rotation that may clear the extension feature.

Ernie Reiter (P. Eng) is a consultant specializing in the design of gears and geared products. He has authored modern software on gearing and other mechanical components, and provides clients with gearing-related design, consulting, software, gaging, training, and support. Since receiving his degree in mechanical engineering in 1985 from the University of Waterloo in Ontario, Canada, Reiter worked in the field of plastics part production for the automotive industry. His various responsibilities include developing tooling and directing the manufacture of molded plastic gears. As part of his engineering duties, he has acquired advanced skills in computer graphics and its application to gear geometry. He is active in five AGMA technical committees, including vice chair positions in both the Plastics and Powder Metal Gearing Committees, and is an active participant in the Fine Pitch, Gear Accuracy and Worm Gearing Committees.

Second Expert Response provided by Fred Young, CEO Forest City Gear (*www.forestcitygear.com*):

(In this case) it could not be made as an enveloping worm gear due to the necessity of continual rotation to achieve full depth. There is no gear machine that can back off for sufficient distance to avoid running into the arm extension 180 degrees to the gear. This also applies to fly cutting the gear. If it was designed as a crossed axis helical, it could easily be shaped on a gear shaper and would run fine against the worm.

You can also make it as a two-piece assembly. Otherwise, this leaves milling it on a five-axis milling machine or perhaps printing it. **PTE**

Fred Young is owner/operator of Roscoe, IL-based Forest City Gear, *www.forestcitygear.com*.

FZG Gearboxes Lubricated with Different Formulations of Polyalphaolefin Wind Turbine Gear Oils

Carlos Fernandes, R. Martins, J. Seabra and L. Blazquez

Five fully formulated wind turbine gear oils were characterized. The gear oils are 320 ISO VG grade and of different formulations, i.e. — four different polyalphaolefins and a mineral. A back-to-back FZG test rig with re-circulating power was used, with a torque-cell included on the rig to measure torque loss. Eight thermocouples monitored temperatures in different locations of the rig. Friction generated between the meshing teeth, shaft seals and rolling bearing losses was predicted.

Introduction

The generation of electricity by wind power is becoming more popular due to the concerns about the effects of global warming (Ref. 1). To make wind energy competitive with other power plants in the near future, enhancements on availability, reliability and lifetime will be required.

In our global economy it is mandatory to increase the efficiency of wind turbines, to reach the highest efficiency of gearbox drives, and their parts and to minimize power loss (Ref. 15). In order to increase gearbox efficiency it is important to quantify the main sources of power loss. The most common wind turbine gearboxes have planetary gears; the main losses occurring are: friction loss between the meshing teeth (Refs. 2-6); friction loss in the bearings (Refs. 2, 7); friction loss in the seals (Refs. 16, 24); no-load gear losses (Refs. 25-29); and energy loss due to air-drag (Ref. 8).

Friction generated between the meshing teeth is the main source of power loss in a gearbox when the torque transmitted is high (Ref. 30). On a gearbox with low transmitted torque, the friction due to viscous forces of the lubricant on the seals, gears and bearings must be accessed in order to correctly predict the power loss. The energy loss due to no-load mechanisms is highly dependent on the lubricant viscosity. The meshing teeth power loss is influenced by the oil formulation and also by their ability to promote a lubricant film while keeping low coefficient of friction.

A back-to-back FZG test rig was used to investigate the torque loss influence of five ISO VG 320, fully formulated, wind turbine gear oils. The operating temperatures of the FZG test rig were monitored in eight different spots with thermocouples. Tests at 1.13, 2.26 and 6.79 m/s (pitch line speeds) were performed for different FZG standard load stages: *K*1, *K*5, *K*7 and *K*9 (arm lever = 0.35 m). Both gearboxes were jet-lubricated with an oil flow of 3l/min. The oil jet input temperature was kept almost constant (80 ± 1°C).

A torque loss model will be presented and the coefficient of friction of each oil formulation will be determined.

Wind Turbine Gear Oils

In order to analyze the different gear oils suitable for the lubrication of wind turbine gearboxes, five fully formulated ISO VG 320 gear oils were selected. In between the selected gear oils, four PAO base oils can be found: PAOR, PAOM, PAOC and PAOX. A mineral-based oil (MINR) was also included as reference.

The FTIR analysis was used in order to identify some of the characteristic peaks of the lubricants (Fig. 1). In the PAO formulations both PAOR and PAOM — which have ester in the formulation to function as comptibilizer for the additives — show a peak in spectra for a wavenumber of 1,800. The PAOX is known to have molybdenum in the formulation while; both PAOC and PAOX are formulated without ester.

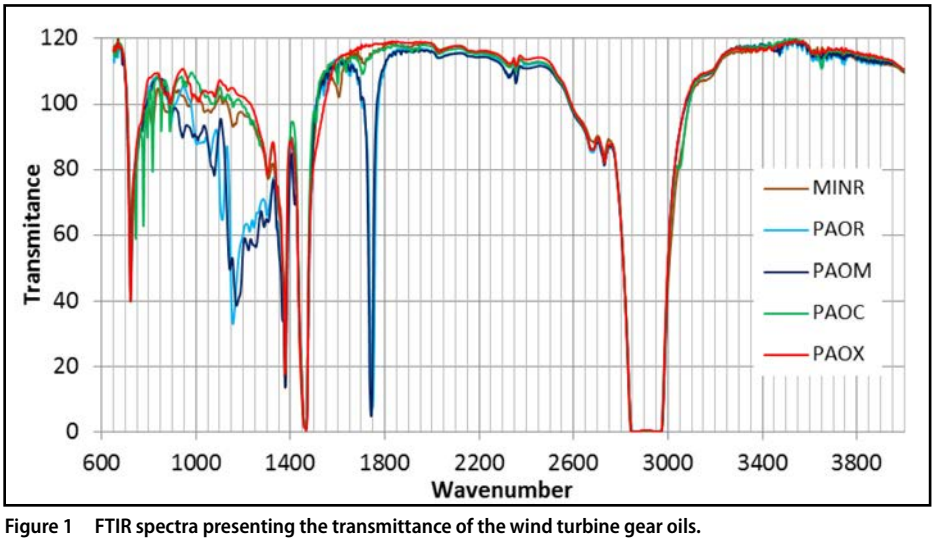

Figure 1 FTIR spectra presenting the transmittance of the wind turbine gear oils.

(This paper was originally presented at the 2014 International Gear Conference, Lyon Villeurbanne, France and is republished here with the authors' permission.)

Table 1 Physical and chemical characterization of wind turbine gear oils

Parameter Base Oil	Unit [-]	MINR Mineral	PAOR	PAOM PAO	PAOC	PAOX
Chemical composition						
Zinc (Zn)	[ppm]	0.9	3.5	4	2	<1
Magnesium (Mg)	[ppm]	0.9	0.5	1	<1	<1
Posphorus (P)	[ppm]	354.3	415.9	448	385	400
Calcium (Ca)	[ppm]	2.5	0.5	6	<1	2000
Boron (B)	[ppm]	22.3	28.4		-	
Silicium (Si)	[ppm]	-		6	3	19
Molybdenum (Mo)	[ppm]	-			12	1150
Sulphur (S)	[ppm]	11200	5020	4436	6265	1800
Physical properties						
Density @ 15°C	[g/cm3]	0.902	0.859	0.863	0.861	0.855
Thermal expansion coefficient	[/] (at.10-4)	-5.8	-5.5	-7.0	-7.4	-7.5
Viscosity @ 40°C	[cSt]	319.2	313.5	332.65	310.07	307.75
Viscosity @ 80°C	[cSt]	43.9	60.4	91.17	86.31	92.41
Viscosity @ 100°C	[cSt]	22.3	33.3	39.25	31.98	30.50
m	[/]	9.066	7.351	7.134	7.302	7.238
n	[/]	3.473	2.787	2.698	2.767	2.739
VI	[I]	85	150	159	152	150

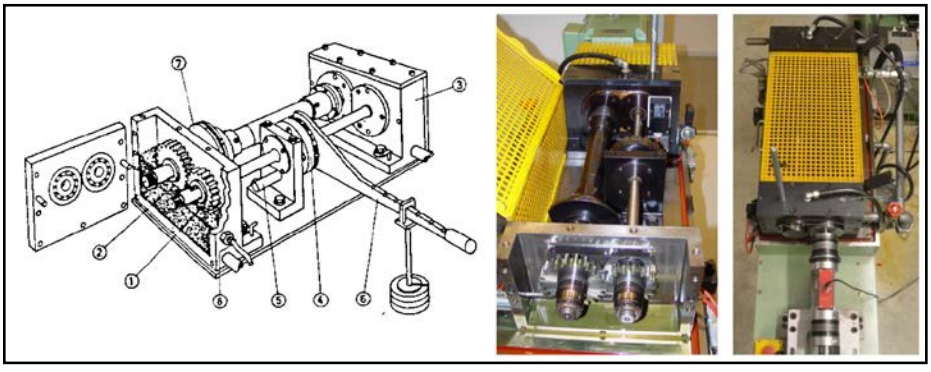

Figure 2 FZG test machine.

Table 1 displays the wind turbine gear oils' physical properties, as well as their chemical composition.

Test Rig

Figure 2 presents the FZG test rig used for this work; the gear test rig uses the recirculating power principle (Ref. 9). Note that the test pinion [1] and wheel [2] are connected to the drive gearbox by two shafts [3]. The shaft connected to the test pinion [1] is divided into two parts by the load clutch [4]. One half of the clutch can be fixed with the locking pin [5], whereas the other can be twisted using the load lever and different weights [6].

The torque loss (T_L) was measured using an ETH Messtechnik DRDL II torque transducer assembled on the FZG test machine. Operating temperatures on several points of the assembly were also measured and recorded using type-K thermocouples. The temperatures were recorded during each test with a sampling rate of 1 Hz.

Table 2 Geometric properties of the gears tested

Gear Type	Type C40	
	Pinion	Wheel
Number of teeth	16	24
Module [mm]	4.5	
Centre distance [mm]	91.5	
Pressure angle [0]	20	
Face width [mm]	40	
Addendum modification [/]	+0.1817	+0.1715
Addendum diameter [mm]	82.64	118.54
Transverse contact ratio Ea Ul	1.44	
Total contact ratio Ey [/]	1.44	
Material	20 Mn Cr 5	
Ra [um]	0.7	

Drive and Test Gearboxes

Gears. The torque loss tests performed in this work used type-C gears with face width of 40 mm usually assembled on FZG drive gearboxes. Table 2 displays the main geometric properties of the C40 gears. The same C40 gearset was used for testing all the lubricants. To assure that a similar surface finish was used with all lubricants, the C40 gear was run-in during 48 hours under dip lubrication with a PAO 150 gear oil. The surface roughness was evaluated before and after the run-in period and the value of the average roughness can be found in the Table 2.

Rolling bearings and seals. The shafts on the test and slave gearbox are supported with cylindrical roller bearings NJ 406 MA. The rolling bearings have a dynamic load capacity of $C = 60.5$ kN and a static load capacity of $C0 = 53$ kN. The rolling bearings have an internal diameter of 30 mm and an external one of 90 mm.

The gearboxes are sealed with four Viton lip seals with an internal diameter of $d_{sh} = 30$mm. A Viton lip seal is also assembled on the drive gearbox motor shaft — $d_{sh} = 26$mm.

Test Procedure

The operating conditions used in the torque loss tests are displayed in Table 3. The tangential speed, power circulating in the system, tangential force transmitted by the gears, radial forces on the rolling bearings and maximum Hertzian pressure in the gears are also included. The oil volumetric flow was set to 3 l/min at a temperature of 80° C.

The test procedure can be summarized as follows:

1. Run load stage *Ki* and rotational speed condition (Table 3) during 3h according to test sequence presented

Table 3 Test conditions for tests performed

		Wheel speed (rpm)					
		200	400	1200	Gears		Rolling bearings
FZG Load Stage	Wheel Torque (T_{s2}) (Nm)	Input power (W)			F_{bn} (N)	P_H (MPa)	F_r (N)
K1	4.95	103.7	207.3	622.0	97.5	179.75	49.5
K5	104.97	2198.5	4396.9	13190.9	2068.6	827.73	1049.1
K7	198.68	4161.2	8322.4	24967.2	3915.4	1138.8	1985.6
K9	323.27	6770.4	13540.9	40622.7	6370.7	1452.6	3230.7

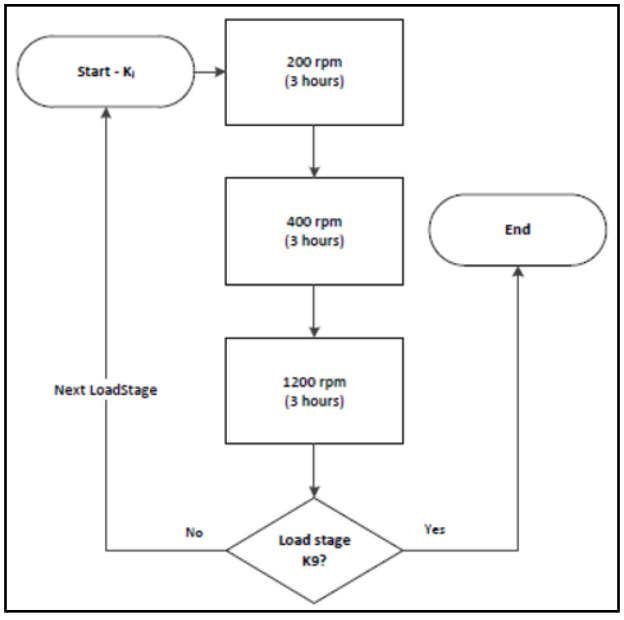

Figure 3 Test sequence.

in Figure 3

- Register the assembly working temperatures
- Continuous torque measurement with a sample rate of 1-measurement-per-second

2. Repeat procedure until the highest load stage

The values presented for torque loss and temperature are the average of the last 30 minutes of operation; i.e. — only the steady state operating conditions are considered for the average calculation. Between each oil test the gearboxes were flushed with solvent, the oil reservoir and the injection system completely drained and cleaned with a solvent.

Experimental Results

This section presents the results for the total torque loss measurements for all test conditions; Table 6 displays the torque loss (*TL*) measurements for all lubricants and test conditions.

Figure 4a displays the torque loss measured for load stage *K*1 at the input speeds of 200,400 and 1,200 rpm. These test conditions were performed to gather knowledge about the torque loss for a no-load condition, i.e. — the results presented are mainly driven by load-independent losses.

PAOC oil generated the lower friction torque loss when load stage *K*5 was applied — regardless of rotational speed selected. At 200 and 400 rpm the PAOM generated higher torque loss than the other PAOs. At 1,200 rpm the no-load losses of the PAGD oil are higher, resulting in the highest total torque loss generated (Fig. 4b). For the tests performed at load stage *K*7, the higher torque loss is again achieved for the PAOM oil. At low speed (200 and 400 rpm) the torque loss generated by PAOR is lower than other oil formulations. At 1,200 rpm all lubricants increase the torque loss. For load stage *K*9 the PAOR oil generated much lower torque loss than the other oils — mainly at lower speed. As speed increases, differences between the oils decrease. The MINR benefits due to the lubrication regime transition and the PAOs are penalized due to their higher viscosity generating higher no-load losses.

Gearbox Efficiency

The calculation of gearbox efficiency in a closed-loop test rig is a function of the static torque installed in the system and the torque applied by the driving motor (designated as torque loss in this work, T_L). A static torque was applied to the pinion shaft (T_{S1}); as a result, the wheel shaft has a higher torque (T_{S2}) related to the pinion torque by the transmission ratio ($i = Z2/Z1$), as represented by Equation 1. The wheel shaft torque values tested were already presented in Table 3.

$$T_{S2} = iT_{S1} \quad (1)$$

The torque loss (T_L) — or the torque applied by the electric motor — was measured on the wheel shaft; the efficiency of the test rig is given by Equation 2.

$$\eta_{Global} = \frac{T_{S2} - T_L}{T_{S2}} \times 100 \quad (2)$$

The test and slave gearboxes have the same gears, and so it is assumed

that both gearboxes have the same efficiency.Thus efficiency of the drive gearbox (η_D) is equal to the efficiency of

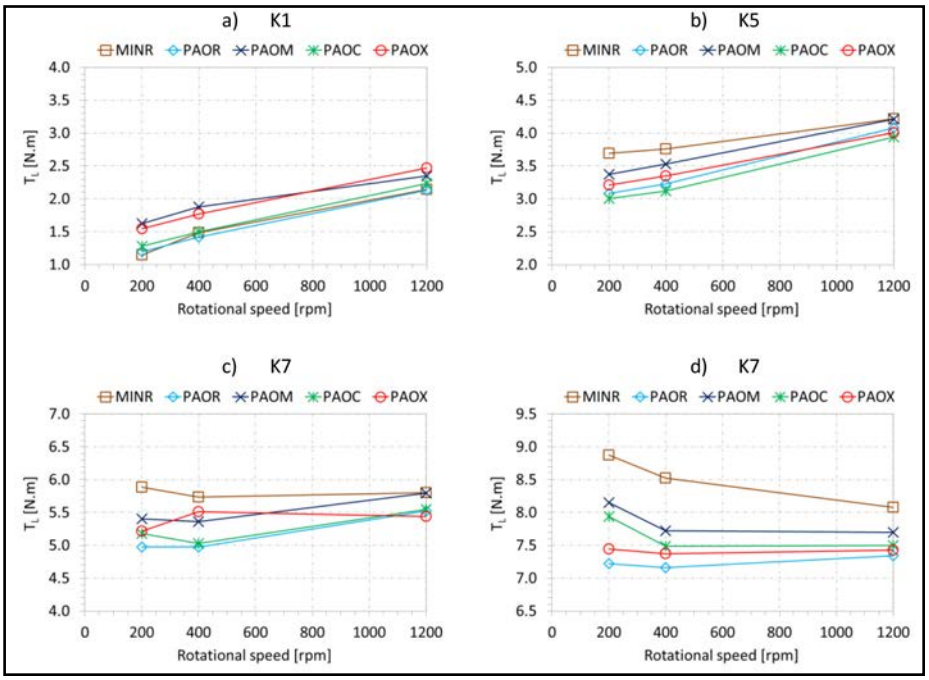

Figure 4 Total torque loss of FZG gearboxes lubricated with different wind turbine gear oils for *K*1, *K*5, *K*7 and *K*9 load stages.

Table 4 Efficiency values (%) calculated for test gearbox.						
		MINR	PAOR	PAOM	PAOC	PAOX
	K1	87.63	87.08	82.00	86.08	82.94
200	K5	98.23	98.52	98.38	98.56	98.46
	K7	98.51	98.74	98.63	98.69	98.68
	K9	98.62	98.88	98.73	98.76	98.84
	K1	83.65	84.43	78.80	83.54	80.13
400	K5	98.19	98.45	98.30	98.50	98.39
	K7	98.55	98.74	98.64	98.73	98.60
	K9	98.67	98.89	98.80	98.84	98.85
	K1	75.30	75.50	72.52	74.10	70.80
1200	KS	97.97	98.04	97.97	98.10	98.07
	K7	98.53	98.60	98.53	98.59	98.62
	K9	98.74	98.86	98.80	98.83	98.84

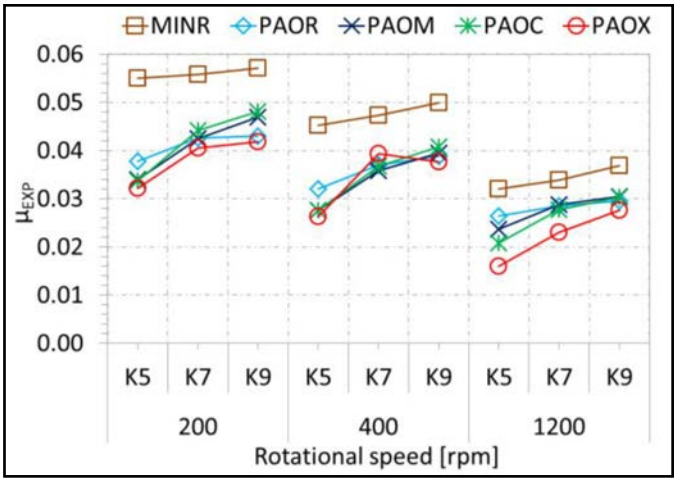

Figure 5 Coefficient of friction on meshing gears.

the test gearbox (η_T) — which is calculated according to Equation 3.

$$\eta_D = \eta_T = \sqrt{\frac{T_{S2} - T_L}{T_{S2}}} \times 100 \quad (3)$$

Table 4 displays the efficiency values calculated for a single gearbox (see Eq. 4 for all the lubricants tested).

Torque Loss Model

The torque loss model presented in this section was used on a previous work (Ref. 10). This model allows determination of the coefficient of friction on the meshing gears using the experimental results; it can be applied to any gear geometry tested in the test rig.

Gear no-load losses. No-load losses were determined for each input speed using the torque loss measured on load stage K1. The no-load losses are calculated subtracting the gear mesh losses, rolling bearing losses and seal losses from the total torque loss on load stage *K*1, as represented in Equation 4. The no-load losses remain equal for higher load stages.

$$T_{VD} = T_L^{K1} - T_{VZP}^{K1} - T_{VL}^{K1} - T_{VD}^{K1} \quad (4)$$

Note that because T_{VZP}^{K1} is very close to zero, the term can be disregarded.

Seal losses. The torque loss of the shaft seals is due to the friction between sealing lip and rotating shaft. Equation 5, proposed by Freudenberg (Ref. 11), was used. Note that this equation only accounts for shaft diameter, and so is independent of the oil used.

$$T_{VD} = 7.69.10^{-6} d_{sh}^2 \cdot \frac{30}{\pi} \quad (5)$$

Rolling bearing losses. In order to understand the torque loss behavior of the rolling bearings, the model proposed by SKF (Ref. 7) was used. The total friction torque is the sum of four different physical sources of torque loss, represented by Equation 6.

$$T_{VL} = M'_{rr} + M_{S1} + M_{drag} + M_{seals} \quad (6)$$

The four sources of torque loss considered by the model are rolling torque (M'_{rr}), sliding torque (M_{sl}), drag torque (M_{drag}) and seals (M_{seals}). The rolling bearings used, NJ 406 MA, do not have seals, so seal losses were not a factor (see Refs. 10, 12 for further explanation).

The sliding coefficient of friction (μ_{sl}) used for each lubricant was determined experimentally, with the results published (Ref. 12) and presented in Table 5.

Table 5 Coefficient of friction for roller bearings		
Oil	μ_{bl}	μ_{EHD}
MINR	0.035	0.018
PAO's	0.039	0.010

Meshing gears losses. Ohlendorf (Ref. 13) was first to introduce an approach for the load-dependent losses of spur gears. The torque loss generated between gear tooth contact can be calculated using Equation 7.

$$T_{VZP} = T_{IN} H_V \mu_{mZ} \quad (7)$$

H_V represents the gear loss factor that is calculated according to Equation 8 for spur gears.

$$H_V = \frac{\pi(u+1)}{Z_1 u \cos\beta_b}\left(1 - \varepsilon_\alpha - \varepsilon_1^2 - \varepsilon_2^2\right) \quad (8)$$

This formula assumes that the coefficient of friction (μ_{mZ}) is constant along the path of contact. The gear load losses for any load stage and input speed are calculated according to Equation 9.

$$T_{VZP}^{Ki} = T_L^{Ki} - T_{VL}^{Ki} - T_{VD}^{Ki} - T_{VZ0}^{Ki} \quad (9)$$

Coefficient of Friction in Meshing Gears

Schlenk (Ref.14) proposed Equation 10 for the average coefficient of friction along path of contact. The lubricant parameter *XL* is equal to 1 for non-additivated (no additives) mineral oils.

$$\mu_{mZ} = 0.048\left(\frac{\frac{F_{bn}}{b}}{v_{\Sigma C}\rho_{redC}}\right)^{0.2} \eta^{-0.05} Ra^{0.25} X_L \quad (10)$$

The coefficient of friction was also derived from experimental results using Equation 11. Figure 5 shows the coefficient of friction for different operating conditions and different gear oils.

$$\mu_{EXP}^{Ki} = \frac{T_{VZP}^{Ki}}{T_{IN} H_V} \quad (11)$$

The lubricant parameter for each wind turbine gear oil was calculated and is presented in Table 6. The experimental coefficient of friction was used to calculate the lubricant parameter of Schlenck's Equation 10. The lubricant parameter is the value that minimizes the error between the experimental coefficient of friction calculated and the values achieved with the Schlenck equation.

Table 6 Lubricant parameter (*XL*) determined for each wind turbine gear oil	
Oil	XL
MINR	0.858
PAOR	0.666
PAOM	0.680
PAOC	0.701
PAOX	0.628

Conclusions

- The results achieved showed that a PAO can reduce more than 10% the torque loss generated with a mineral oil (MINR).
- The model implemented suggests a better behavior of the PAOX on the meshing gears torque loss, which can be verified by the coefficient of friction generated.
- For example, the lubricant parameter used to score the oils in Schlenk equation, can have differences higher than 7% when compared with two different PAO, PAOC and PAOX.

Aknowledgements. *This work was funded by national funds through FCT-Fundação para a Ciência e Tecnologia within the project EXCL/EMS-PRO/0103/2012.* **PTE**

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Carlos Fernandes received his PhD degree in mechanical engineering (2015) from Faculdade de Engenharia da Universidade do Porto, Portugal. Previously, in 2010 he joined INEGI research institute as a post-doctoral researcher. Fernandes's main research topics are mechanical transmissions with emphasis on gears and rolling bearings efficiency.

Ramiro C. Martins joined INEGI in 1999 as a researcher of tribology topics, and since 2010 as auxiliary researcher in the same industry sector. He graduated in 1999 with a degree in mechanical engineering from the Engineering Faculty, Porto University, Portugal and went on to gain his MSc in structural engineering (2002) and a PhD (2008) in mechanical engineering — both from Porto University. Martins's primary research topics include contact mechanics; EHD lubrication; surface failure; gear micropitting; pitting; oil rheology; surface coatings; and gear power losses.

Jorge H.O. Seabra joined the Engineering faculty of Porto University in 1981. He is a member of the Portuguese Association for Professional Engineers and of the Society of Tribologists and Lubrication Engineers, USA. A 1981 graduate with a mechanical engineering degree from Porto University, Portugal, he also holds an MSc in structural engineering from Porto (1985) and a PhD from the Institut National des Sciences Appliquées, Lyon, France (1988). His coursework includes rigid body dynamics, tribology — i.e., EHD lubrication and Hertzian contact mechanics. He is also director of the masters course in mechanical engineering at Porto University and of the unit for tribology, vibrations and industrial maintenance at INEGI. Seabra's research concentrations are contact mechanics; EHD lubrication; surface failure; gear pitting and scuffing; oil and grease rheology; triboreactive materials; and lubricant condition monitoring.

Luis Blazquez is currently industrial business development manager for South Europe in BP Lubricants (of the BP Group), focusing during the last five years on wind energy. He earned his Licentiate degree in mechanical engineering at Instituto Superior Técnico, Lisboa Portugal, in 1994, and his MBA in Finance from ISEG (Lisboa Scholl of Economics and Management), Lisboa Portugal in 2003. Belazquez joined BP Lubricants in 1994, working in a variety of engineering and commercial posts. For the last ten years he has held senior sales & marketing management roles, always with international exposure, developing new businesses and managing complex customer negotiations and relations at different levels. Belazquez is a recognized European lead expert in the high-performance lubricants area within BP/Castrol, representing the company in several forums and as co-author of other energy efficiency studies in wind turbines gearboxes.

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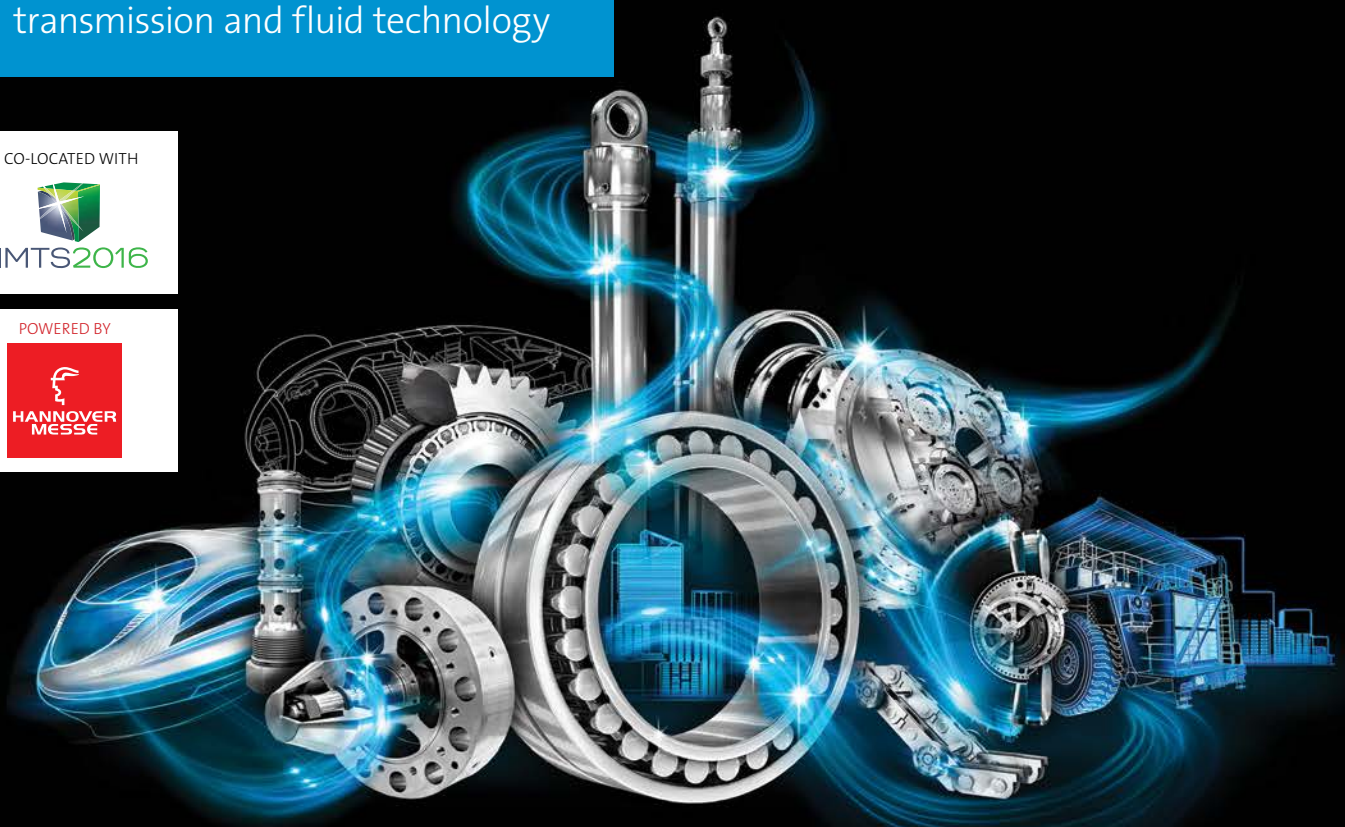

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Hands-On Manufacturing

FOUR WAYS SKF USA INC. IS TRYING TO MAKE YOUR JOB EASIER

MATTHEW JASTER, SENIOR EDITOR

There's plenty of work to do. Whether you're on a manufacturing site or sitting at your desk rifling through two-weeks-worth of e-mails, projects keep coming. The 2016 engineer, however, has it much easier than the 1988 version. He or she can browse CAD downloads online, shuffle through product catalogs on their smartphones or learn how to properly mount bearings with a click or two of the mouse. SKF USA Inc. recently shared some of its tried and true engineering methods during the 2016 Technical Press Event in Philadelphia, PA. Here's a short recap:

#1 The Evolution of Connectivity

Mark Hinckley, director, strategic projects, SKF, used to carry a very large workbag to manufacturing sites. This included his laptop, a bulky battery pack and a couple of physical SKF product catalogs. In the late 1990s and early 2000s, we all had work bags that looked like this. We stuffed our bagged lunches between file folders, notepads and various books. Our shoulders hurt, our backs were sore and our designer workbags took a beating right down to their deep hidden pockets.

Hinckley only takes his iPad to manufacturing sites today as well as a small, easy-to-manage workbag he can quickly sling over his shoulder. Instead of two large product catalogs, Hinckley has access to SKF's entire product library right on his tablet. He was simply making a point to show a room full of editors at SKF's Technical Press Day 2016 that technology is making it easier for everyone to do business in 2016.

Today, SKF has developed over 45+ apps for smartphone and tablet users simply because there is an industry-wide need for such resources. Whether its engineering/selection tools, educational apps, trade show support, industry specific apps or condition monitoring/alignment tools, SKF has been vigilant in equipping both its customers and employees with mobility tools that are useful and improve the way we collect and distribute information.

Some of these resources have been available for some time such as *SKF's Bearing Calculator* (the most downloaded app from the SKF collection) which simply makes it easy to perform complex bearing calculations. Others like *DataCollect by SKF*, provides intuitive data collection for machine inspections to help engineers be more efficient on the job. *PM Motors from SKF* is the company's first augmented reality app that allows engineers to virtually look inside a 3D magnetic system and provides data for all the key components.

Why are these technologies so important today? Manufacturing is going through some significant changes, not in the manufacturing itself, but the way in which the data is collected, processed and managed. Mechanical component manufacturers must adapt in order to stay ahead of the competition. In short, it's time to ditch that old, bulky workbag and buy into something much more practical.

2 Blank Sheet Engineering

Laurie Olson, specialty sales and marketing manager, SKF, could be considered a bearing detective of sorts. She's responsible for meeting with clients and coming up with custom solutions when off-the-shelf bearings won't get the job done. These custom solutions typically offer higher performance capabilities and are engineered for the technical demands of a specific application.

Where would such bearings fit in the manufacturing world? (Pumps, turbines, conveyors, electric motors, paper mill rolls and steelmaking equipment to name a few). These solutions are tailored to meet the unusual operating conditions engineers must deal with in the field such as extreme temperatures, corrosive environments, high-speed applications or simply a critical component that can't afford to fail.

Olson believes this is possible with a blank sheet engineering approach. SKF engineers identify and review all existing application data for the application in question (speed requirements, load information, environmental concerns, etc.). They select the appropriate modeling software and input design options that will fit the customer's needs.

It's detective work, as mentioned earlier, but new bearing designs can create non-standard geometries and sizes, integrated outer or inner rings, custom assemblies, seals and shields, custom clearances and a range of additional innovations. With new materials, increased service capabilities and hybrid bearing options, SKF technology is helping take the guesswork out of custom bearing designs.

#3 Proper Seal Selection

Seals for bearing arrangements should provide a minimum amount of friction and wear while providing maximum protection under the harshest conditions. Bearing performance and service life are ultimately tied to the effectiveness of the seal as well as the influence of contaminants. These should be key design considerations at the early stage of the bearing manufacturing process.

According to Bryan Uncapher, director business development, seals, SKF, the primary functions of seals include retaining lubricant, separating media, excluding contaminants and resisting pressure. Several factors to consider when determining what seal material should be used include temperature range, pressure range, fluid media to be sealed, duty cycle, surface speed, the working environment and friction and installation concerns.

Uncapher described how important it is to identify the different factors that can influence seal material selection. For example, some materials such as polyurethane and rubber provide better sealing properties but polytetrafluoroethylene (PTFE) and polyetheretheketone (PEEK) provide better chemical and temperature resistance. He recommends re-

searching each sealing application on a case by case basis to determine the best course of action.

SKF has 100+ years of experience in various industries and applications including seals for the wind industry, tunnel boring machines, agricultural equipment (combines), gearboxes and steel mills.

#4 Asset Management

Mike Trainor, manager asset reliability consulting, believes a good maintenance program starts with the right roadmap. The company must universally agree on the criteria and the path forward. You must understand how an asset fails and its consequence. Basically learn what you've done in the past, know what it means and take action. This starts by prescribing maintenance activities to detect, prevent or eliminate asset failures. "We cannot prevent equipment from degrading toward failure but we can prevent business consequences by intervening at the appropriate time," Trainor said.

Putting these ideas into action, SKF worked with a power producer to improve uptime. The customer was experiencing reliability and performance problems. This customer wanted to improve performance by decreasing equipment failure. SKF worked with 27 units to determine an applicable and effective maintenance strategy for both the critical and non-critical assets. After 30 months of implementation, the customer reported a 30 percent reduction in equivalent forced outage rate (EFOR) a 7 percent increase in peak period reliability and a 30 to 40 percent reduction in high priority corrective work.

In another example, a heat treat facility had large amounts of downtime after the initial install. This was a result of many breakdowns and also a lack of critical spare parts. SKF came up with a preventative maintenance, inspection and spare parts program to eliminate downtime. After three months of implementation, the facility went from 46 percent unplanned maintenance hours down to 12 percent.

Hitachi Automotive Systems

RECOGNIZES C&U AMERICAS AS A TOP SUPPLIER

Top executives from C&U Americas, LLC enjoyed the best of both worlds on Saturday, June 4, 2016 at the 2016 Chevrolet Detroit Belle Isle Grand Prix in Detroit, MI. In addition to the honor of being recognized as a top supplier, C&U Americas President, Tom Rouse and Matthew Unsworth, director of sales, were honored guests in the Hitachi Automotive Systems Americas, Inc. suite during the 20th running of Detroit's premier open wheel racing spectacular and had the opportunity to partake in some exciting 'varoom' trackside.

Helio Castroneves (left), Hitachi Team Penske Chevrolet driver, with Tom Rouse, C&U Americas president, on race day during the 2016 Chevrolet Detroit Belle Isle Grand Prix in Detroit, MI.

According to Rouse, "We are delighted to receive this prestigious recognition and could not ask for a more enjoyable way to celebrate the day with our valued partner, Hitachi Automotive Systems, and help them cheer on their driver, Helio Castroneves, and the Hitatchi Team Penske Chevrolet."

Hitachi Automotive Systems Americas, Inc. President and CEO, Paul Carroll, noted, "C&U earned the opportunity because of their overall achievement on quality, cost savings, delivery, and innovation. They are one of our very best suppliers and in a class of elite suppliers in our industry. This is the first time we have had this type of award and we were very pleased to be able to host C&U Americas for this event."

Schaeffler

SUPPLIES KEY COMPONENTS FOR NEW PANAMA CANAL

After a nine-year construction period, the new, third channel of the Panama Canal opened recently. Starting immediately, ships with a maximum length of 366 meters (984 feet) and a width of around 50 meters (164 feet) can travel this shortcut between the Atlantic and Pacific oceans. Until now, the passage was restricted to ships that were no more than 290 meters (951 feet) long and 32 meters (105 feet) wide. Bearing solutions from Schaeffler keep lock gates and valves moving.

Bearings for reliable lock operation

Components made by Schaeffler play a key role in the operation of the lock gates. The locks are necessary both on the Atlantic and Pacific side so that ships can overcome a difference in height of 26 meters and pass through the interior of the country. This is achieved by three consecutive locks that are flooded with water from adjoining reservoirs. The lock gates are made of reinforced concrete and have enormous dimensions of 50 meters (164 feet) wide, 30 meters (98 feet) high and 10 meters (33 feet) thick. For safety reasons, two gates have been installed for each barrage that open to the side. The mechanism for opening and closing the gates was developed by Italian engineering company Cimolai Technology. To open and close the gate, each has two main drive units that drive a cable winch. The drums of the steel cable winches are supported by spherical roller bearings made by Schaeffler. Since very high torques of up to 330,000 Nm are required to move the gates, there is also a gearbox on each that increases the torque of the electric motors by almost 280 times. The gearboxes developed by PIV Drives, a company owned by the Brevini Group, are equipped exclusively with tapered, spherical and cylindrical roller bearings made by Schaeffler. Most of the bearings have been coated with Schaeffler's Triondur C to prevent wear and ensure their operation for 35 years.

Both at the top and at the bottom of the reservoirs, two "carriages" guide the gates that weigh 3,100 tons. The guide pulleys that are used must be able to withstand not only the weight of the, but also the pressure of 430 million liters of water per reservoir. The guide pulleys are equipped with spherical roller bearings supplied by Schaeffler.

Bearings for Resource-Conserving Water Cycle

One important feature of the new Panama Canal is its three reservoirs that are located next to each barrage. They ensure a resource-conserving water cycle. Several valves open in a channel below ground to drain the water from a barrage. The channel connects the water saving basins and the barrage. Due to the large size of up to seven meters (23 feet), the valves supplied by Hyundai Samho have also been designed as gates. The steel guide pulleys for these gates are equipped with bearings made by Schaeffler. The bearings used here are chromium-plated, making them particularly resistant to corrosion. Different variants of the Durotect coating developed by Schaeffler are used for this application.

Challenging Conditions

Schaeffler Engineer Francesco Capittini describes the special challenges for bearing solutions for the Panama Canal as follows: "The slow motion causes a quasi-static load in the bearings with very high forces."

In addition, the operation of the Panama Canal must work reliably 24/7 due to its significance for world trade. Maintenance intervals are scheduled only every five years.

Schaeffler was able to develop solutions based on standard products despite the tough requirements for technology in the expansion of the Panama Canal. The international network of engineers and application specialists also implemented project-specific solutions. Dr. Stefan Spindler, who is a member of Schaeffler's executive board and responsible for the company's industrial business, explains: "Our sales team is made up of engineers all over the world. They work with Schaeffler experts from a wide range of disciplines, such as coating engineers and calculation experts, which helps them provide our customers with bearing solutions for even the most challenging applications."

Matteo Maretto, member of the development team at Cimolai Technology, the Italian engineering company that developed the mechanism for moving the lock gates, agrees: "The bearings are a very critical component for the overall functioning of the lock. They have to work under any circumstances; otherwise the entire facility would stand still. Schaeffler provided valuable support to us during development."

The Timken Company

ACQUIRES INDUSTRIAL COUPLING MANUFACTURER LOVEJOY INC.

The Timken Company has announced that it has acquired Lovejoy, Inc., a manufacturer of premium industrial couplings and universal joints, for approximately $66 million. For the 12 months ending March 31, 2016, Lovejoy sales were approximately $56 million.

"The acquisition of Lovejoy is a great strategic fit, and we're pleased to add their strong brand to our growing portfolio of industrial brands," said Richard G. Kyle, Timken president and chief executive officer. "Lovejoy features premium products used in challenging applications across diverse markets. While our two companies operate in many of the same markets and channels in North America, the acquisition provides exciting growth opportunities."

Based in Downers Grove, IL, with additional locations in the U.S., Canada and Germany, Lovejoy is widely recognized for its flexible coupling design and as the creator of the jaw-style coupling. Lovejoy also manufactures a line of universal joints, hydraulics and vibration dampening products. The company's Lovejoy, Curtis and RunRight products are considered a mainstay in diverse industries including energy, fluid power, food and beverage, aggregate, paper and steel. Lovejoy employs approximately 300 people.

"We're pleased to become a part of such a well-respected industrial leader as Timken," said Mike Hennessy, chairman of the board of Lovejoy. "Under Timken ownership, Lovejoy's technical leadership and commitment to customers will carry forward seamlessly. It's clearly a win-win for our customers and our employees."

The Hennessy family has owned and operated Lovejoy for four generations and as part of the transaction, Hennessy will be retiring. "We have a great deal of respect for the business, brand and talented team they have built through the years," said Kyle.

This acquisition adds to The Timken Company's growing portfolio of mechanical power transmission products. In recent years, Timken has been diversifying its offering, completing a number of acquisitions featuring products adjacent to its core bearing lines. This includes belts, chain, gear drive systems, lubrication systems and a variety of related services, all marketed under strong industrial brands including Timken, Philadelphia Gear, Carlisle, Drives and Interlube. Timken expects the acquisition to be accretive to earnings in the first year of ownership, excluding one-time transaction costs.

Happach Named President of Lovejoy

The Timken Company has announced that Mathew W. Happach has been named president of Lovejoy, Inc. At the same time, Lovejoy's CEO Woodrow "Woody" Haddix assumes the role of advisor to the president, supporting Happach through the transition period. Timken announced that it has acquired Lovejoy, adding the premium manufacturer of industrial couplings and universal joints to the Timken lineup of mechanical power transmission products.

"Mat brings great experience in the power transmission space as well as broad leadership skills to his new role," said Hans Landin, vice president of mechanical power transmission products for Timken, in announcing the appointment.

"He and Woody share the same goal: to build the Lovejoy business and brand while ensuring that customers continue to experience the high levels of service and support that have long been a Lovejoy hallmark."

Lovejoy, Inc., is based in Downers Grove, IL, with additional locations in the U.S., Canada and Germany. Widely recognized for its flexible coupling design and as the creator of the jaw-style coupling, Lovejoy also manufactures a line of universal joints, hydraulics and vibration dampening products. The company's Lovejoy, Curtis and RunRight products have long been mainstays to diverse industries including energy, fluid power, food and beverage, aggregate, paper and steel.

A Timken associate since 1987, Happach has extensive experience in OE and distribution sales, marketing and planning functions. He has served as director of aerospace bearings, managing director for Europe, managing director for Korea and Japan, and also was vice president of the global rail businesses. Previously Happach also held leadership positions in global marketing and business planning and was the director of sales and marketing for the Timken business in India.

Happach received a bachelor's degree in mechanical engineering from Bradley University and holds a master's degree in business administration from The University of Texas at Arlington. Happach and his wife will relocate to the Chicago area in the near future.

Haddix most recently was chief executive officer of Lovejoy, Inc., and has extensive industry experience. Prior to Lovejoy, he held positions in Premier Industrial, Hawk Powder Metal Group and International Harvester. He earned both a bachelor's degree and a master's of business administration degree from DePaul University.

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September 12-15–Turbomachinery and Pump Symposia 2016

George R. Brown Convention Center, Houston, Texas. The Symposia's technical program (more than 100 technical sessions), presented by engineers and selected by an advisory committee of industry experts, includes topics such as maintenance, design and troubleshooting, as well as short case studies describing in-the-field problems and their real-world solutions. An exhibit hall hosts 340+ booths of leading companies from the oil and gas, petrochemical, power, pumping and turbomachinery industries. For more information, visit *pumpturbo.tamu.edu*.

September 12-17–IMTS 2016

McCormick Place, Chicago, Illinois. The International Manufacturing Technology Show is one of the largest industrial trade shows in the world, featuring more than 2,000 exhibiting companies and 114,147 registrants. This year's show is expected to be one of the largest IMTS events at 1.3 million net square feet with a full line up of exhibitors showcasing the latest technology. After you register, also consider reserving your hotel room through Connections Housing, the only IMTS housing provider. Don't wait to book, as rooms in the downtown area sell out months before the show. Motion, Drive & Automation North America will return as a co-located event with IMTS 2016 and will present the latest technologies and solutions in power transmission, motion control and fluid technology. For more information, visit *www.imts.com*.

September 16-17–EASA Principles of Medium and Large AC Motors

Wyndham Garden Hotel Philadelphia Airport, Essington, PA. This course from the Electrical Apparatus Service Association (EASA) covers horizontal and vertical squirrel-cage induction motors in the 300 to 5,000 horsepower range, low and medium voltage, most of the principles covered apply to other sizes as well. This seminar focuses primarily on NEMA motors. Seminar highlights include motor theory, applications, safety considerations, root cause failure analysis, test and inspection procedures, starting methods and connections, accessories, stator construction and design, rotor construction and design, bearing types and lubrication systems, shaft construction, motor geometry and alignment, vibration, noise, cleaning, reconditioning and storage. For more information, visit *www.easa.com*.

September 19-21–2016 Petroleum and Chemical Industry Technical Conference

Philadelphia, PA. The Petroleum and Chemical Industry Committee (PCIC) of the Industry Applications Society of IEEE invites attendees to its 63rd annual conference in Philadelphia. Technical sessions include DOE regulations, hazardous materials, standards and practices, electric motors, transformers, variable speed drives, control strategies and more. For more information, visit *http://ewh.ieee.org/soc/ias/pcic/conferences/*.

September 24-28–WEFTEC 2016

New Orleans Morial Convention Center. The Water Environment Federation's Annual Technical Exhibition and Conference, is the largest conference of its kind in North America and offers water quality professionals from around the world with the best water quality education and training available today including 29 workshops, 130 technical sessions, 16 mobile sessions on the exhibit floor, facility tours and more. The expansive show floor provides access to the most cutting-edge technologies in the field; serves as a forum for domestic and international business opportunities and promotes invaluable peer-to-peer networking among registrants. For more information, visit *www.weftec.org*.

September 26-28–MINExpo International 2016

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

September 26-29–Gear Dynamics and Gear Noise Short Course

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

October 2-5–GMRC Gas Machinery Conference 2016

The GMRC Gas Machinery Conference provides three days of technical training and presentations by the industry's leading experts. The conference includes a vendor exhibit showcasing the latest equipment, technology and services. Educational sessions and networking opportunities are valuable for design engineers, facility engineers, technicians and others, with an emphasis on the operation, maintenance and testing of gas compression machinery. The Gas Machinery Research Council (GMRC) is a not-for-profit research corporation that was founded in 1952. GMRC provides its member companies and industry with the benefits of an applied research and technology program directed toward improving reliability and cost effectiveness of the design, construction and operation of mechanical and fluid systems. For more information, visit *www.gmrc.org/gmc*.

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Hertha Marks Ayrton

Crasher of Boys Clubs, Maker of (Electrical) Waves

Jack McGuinn, Senior Editor

She was born Phoebe Sarah Marks April 28, 1854 in Portsea, Portsmouth, Hampshire, UK—the third child of a Polish-Jewish watchmaker named Levi Marks and Alice Theresa Moss, a seamstress. Her father died in 1861, leaving Sarah's mother with seven children—and another on the way—and Sarah with shared responsibility for caring for the children.

But after that—it was clear the decks and give this woman—to become known as Hertha Ayrton (in what could be construed as a cagey career move, she married her professor)—a wide berth.

Marks was a British engineer, mathematician, physicist, inventor and non-stop energy force. And something else—self-proclaimed agnostic. Known today as Hertha Ayrton, she dropped her given name and adopted the name "Hertha," after the eponymous heroine of a Swinburne poem criticizing organized religion. Perhaps her ultimate achievement—or recognition, certainly—was winning the highly coveted Hughes Medal by the British Royal Society for her work with electric arcs and ripples in sand and water; as of 2015 Hertha remains the first of only two women medalists.

Hertha Marks Ayrton

At age nine—in a decidedly Dickensian scenario—Hertha went to live with two aunts, who also ran a school in London. She was soon introduced to the math-and-science, STEM-type subjects of the day; by 16 she was working as a governess.

Hertha attended Girton College, University of Cambridge to study mathematics. George Eliot (Mary Ann Evans for the non-English Lit majors among us) endorsed Ayrton's application.

While at Cambridge Ayrton built a sphygmomanometer, led the choral society, helped start a math club, and *founded the Girton fire brigade*. In 1880, although demonstrably qualified, Cambridge did not confer an academic degree because Cambridge conferred only certificates—not full degrees—to women. Not to be deterred, Ayrton in 1881 passed exams at the University of London that led to a Bachelor of Science degree.

Upon returning to London, Ayrton made her way by teaching and embroidery, running a club for working girls, and caring for her invalid sister. She also taught at Notting Hill and Ealing High School.

Ayrton's first patent was awarded in 1884—a line-divider—or engineering drawing instrument—for dividing a line into any number of equal parts and for enlarging and reducing figures. Hertha went on to register 26 patents, including 13 on arc lamps and electrodes, and 8 devoted to air propulsion power.

In 1884 Hertha attended "night school" classes on electricity presented by Professor William Edward Ayrton, a pioneer in electrical engineering and physics and a fellow of the Royal Society. As mentioned, they married the following year, she becoming his assistant with his experiments. Meanwhile, Hertha began her own investigation into the characteristics of the electric arc. In the late nineteenth century electric arc lighting was everywhere, but its tendency to flicker and hiss had been a major problem.

Hertha in 1895 began a series of articles for the *Electrician*, theorizing that these arc lighting issues were caused by oxygen exposed to the carbon rods used to create the arc. And, in 1899, she was the first woman allowed to present her own paper before the Institution of Electrical Engineers (IEE)—"The Hissing of the Electric Arc." Hertha was subsequently elected the first female member of the IEE; the next to be admitted would be in 1958. Several years later, Hertha petitioned to present a paper before the Royal Society, and again was thwarted. The ground-breaking work—"The Mechanism of the Electric Arc"—was instead presented in 1901 by noted electrical engineer John Perry.

Thus by the late nineteenth century Ayrton's work was recognized more widely. Hertha published *The Electric Arc*, a summary of her research and work on the electric arc, in 1902, further validating her place among her male "peers" as a serious contributor to electrical engineering.

Or did it?

Hertha in fact continued to be spurned by the traditional scientific societies of her day. After the 1902 publication of *The Electric Arc*, Hertha was proposed as a Fellow of the Royal Society by Perry; her application was refused on grounds that married women were not eligible. Hertha persevered and in 1904 became the first woman to present before the Society, reading her paper "The Origin and Growth of Ripple Marks," which was subsequently published in the *Proceedings of the Royal Society*—yet another first for the feisty feminist.

Sadly, this woman of science, now an acknowledged giant in her field, was stricken with blood poisoning. She died in 1923. (*Source: Wikipedia*) **PTE**

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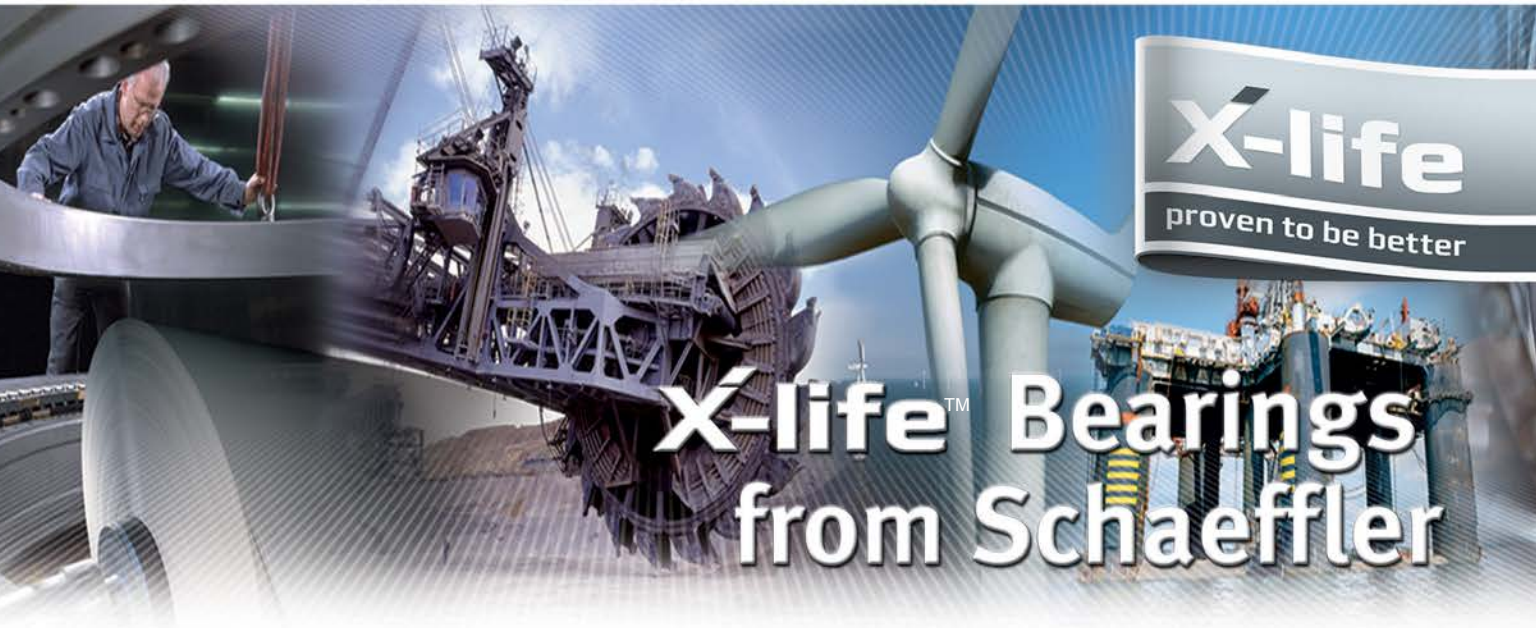

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