Power Transmission Engineering®

OCTOBER 2016

NEWEST GEARMOTOR TECHNOLOGY

- TIMKEN SEALS GUIDE
- PACK EXPO PREVIEW
- BEARINGS STANDARD CHALLENGED

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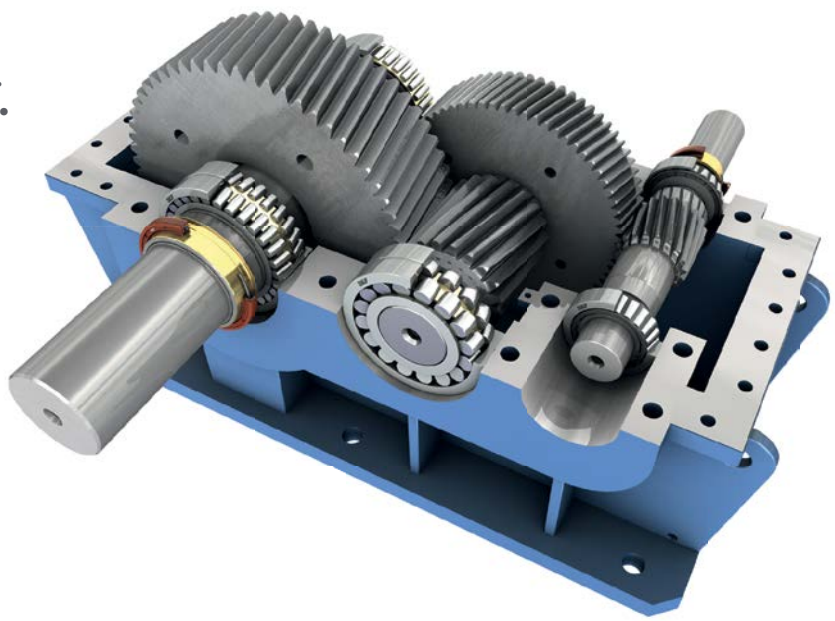

SKF is helping both manufacturers and end users optimize industrial transmission performance. Solutions ranging from upgraded SKF Explorer spherical roller bearings to automatic lubrication systems can enable reduced friction, increased torque and lower energy use, all while increasing bearing service life and extending maintenance intervals. When needed, complete gearbox remanufacturing services from SKF can return gearboxes to like-new condition.

For more information, visit **skf.com**.

SKF®

Power Transmission Engineering®

OCTOBER 2016

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FEATURE ARTICLES

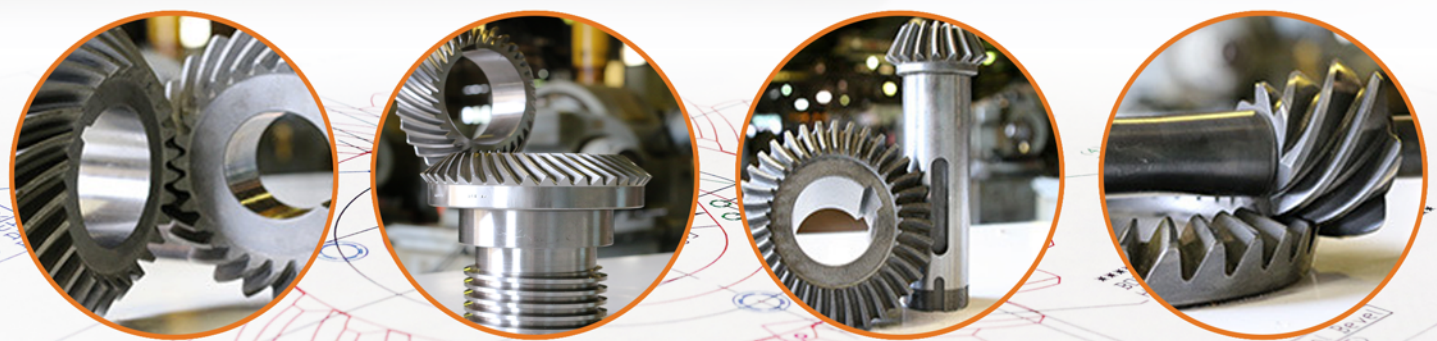
TECHNICAL ARTICLES

Vol. 10, No. 7. POWER TRANSMISSION ENGINEERING (ISSN 2331-2483) is published monthly except in January, May, July and November by Randall Publications LLC, 1840 Jarvis Ave., Elk Grove Village, IL 60007, (847) 437-6604. Cover price $7.00. U.S. Periodicals Postage Paid at Elk Grove Village IL and at additional mailing offices. Send address changes to POWER TRANSMISSION ENGINEERING, 1840 Jarvis Ave., Elk Grove Village, IL 60007.

Power Transmission Engineering
VOL. 10, NO. 7

Gearing your past to power your future.

Quality precision with every process.



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We understand the urgency of meeting critical deadlines. We offer our customers expedited services without sacrificing quality.

Heat Treatment

Our in-house heat treat facility performs a full range of services that include annealing, carburizing, and thru hardening.

B&R MACHINE AND GEAR CORP

B&R Machine and Gear Corporation is a full service gear manufacturing facility driven to power your equipment with reliable and durable gears that are built to perform and last. Find the perfect mesh. No matter the gear, we've got you covered.

VISIT OUR WEBSITE BRGEAR.COM FOR MORE INFORMATION

www.powertransmission.com

PTE Videos

We've Got You Covered!

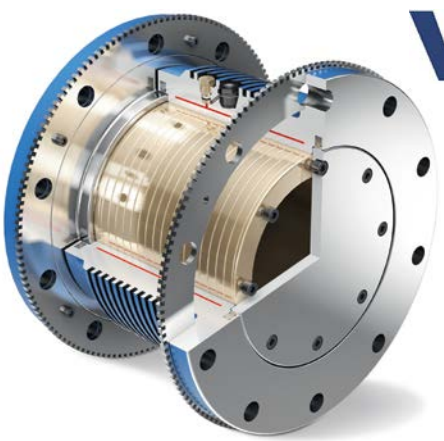
Stop by *www.powertransmission.com* to view videos on new products and technologies recently featured online across the PT industry including information from Schaeffler and Maxon.

Back to Basics

Our continuous push to get you the technical information you need regarding gear manufacturing just got easier at *www.powertransmission.com*. Our Back to Basics section delivers quick access to topics such as application guides, product selection and sizing, gear design and more. This section is perfect for anyone new to the gear industry or for those looking to refresh their skills.

More Suppliers, More Choices

The online Buyer's Guide at *www.powertransmission.com* is constantly improving by adding new suppliers of gears, bearings, belts, clutches, couplings, motors and other mechanical power transmission components. Stop by the site to see who's been added recently.



VOITH

Voith Turbo Inc. was recently added to the *PTE* Buyer's Guide.

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Randall Publications LLC
1840 Jarvis Avenue
Elk Grove Village, IL 60007
Phone: (847) 437-6604
Fax: (847) 437-6618

EDITORIAL

Publisher & Editor-in-Chief
Michael Goldstein
publisher@powertransmission.com

Managing Editor & Associate Publisher
Randy Stott
wrs@powertransmission.com

Senior Editor
Jack McGuinn
jmcguinn@powertransmission.com

Senior Editor
Matthew Jaster
mjaster@powertransmission.com

News Editor
Alex Cannella
alex@geartechnology.com

Editorial Consultant
Paul R. Goldstein

ART

Art Director
David Ropinski
dropinski@powertransmission.com

ADVERTISING

Advertising Sales Manager & Associate Publisher
Dave Friedman
dave@powertransmission.com

China Sales Agent
Eric Wu
Eastco Industry Co., Ltd.
Tel: (86)(21) 52305107
Fax: (86)(21) 52305106
Cell: (86) 13817160576
eric.wu@eastcotec.com

Materials Coordinator
Dorothy Fiandaca
dee@randallpublications.com

DIGITAL

Content Manager
Kirk Sturgulewski
kirk@powertransmission.com

CIRCULATION

Circulation Manager
Carol Tratar
subscribe@powertransmission.com

Circulation Coordinator
Barbara Novak
bnovak@powertransmission.com

RANDALL PUBLICATIONS STAFF

President
Michael Goldstein

Accounting
Luann Harrold

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OFFSET SHAFTS. SOLVED.

Offset Couplings from Zero-Max reduce space requirements for parallel offset shafts in large system applications. These specialized couplings provide machine designers with an important option for reducing overall machine size and footprint.

Compact in design, Schmidt Offset Couplings transmit constant angular velocity and torque in a wide range of parallel shaft misalignments. Handling high amounts of parallel offset up to 9 inches, they are available with torque capacities up to 459,000 in-lbs.

Schmidt Offset Couplings can be mounted to shaft hubs or directly to existing machine flanges. They are available for shaft displacements of 0.156 inches to 17.29 inches and torque capacities from 55 to 459,000 inch-pounds. Many design configurations are available including specials.

ZERO-MAX®

www.zero-max.com 800.533.1731

Randy Stott, Managing Editor

Kids Love Technology

Last month, I took four students to IMTS, including my son Matt, his girlfriend, Kate, and my daughters Emily and Renee.

Kate, a sophomore studying engineering at the University of Wisconsin-Platteville, has a genuine interest in manufacturing, so it was natural that she attend IMTS. But the other three? My kids? Well, let's just say that their interests lie elsewhere. Matt, also a sophomore, is studying business at UW-Platteville. Emily, a sophomore in high school, wants to join the Peace Corps. Renee, an eighth grader, wants to be a surgeon.

So you might think IMTS—North America's largest manufacturing technology show—would be a recipe for boredom. You might think I had to drag them there kicking and screaming. But no, this wasn't just Dad coming up with yet another method of teenage torture. Believe it or not, they actually wanted to go.

That's because, like most kids, they're curious about the world and how things work. Even if they've never thought about engineering-focused careers, they're interested in learning what's out there. I took them to IMTS because I wanted them to see and understand that all the stuff they use every day doesn't just magically come from *Amazon.com*. Somebody has to design it. Somebody has to engineer it. Somebody has to make it. I took my kids to IMTS because I wanted them to see that manufacturing and engineering can be pretty darn cool.

And you know what? The show delivered.

I mean, where else can you have an ice cream cone delivered to you by a robot (thanks to Kawasaki), use a mechanical press to build your own yo-yo (thanks to Promess Inc.), and try out augmented reality using Google Glass (thanks to Beckhoff Automation)? We got to see 3-D printed cars. We got to design and launch our own air-powered rockets. And we got to talk to people who make things for a living.

Thanks, IMTS, for giving us the opportunity.

Speaking of opportunities, you all have them, too, and you should take advantage of them. I'm sure you know some kids. Like mine, they're probably not all that interested in engineering or manufacturing. They probably have no idea how things are made. But you can help.

Open up your factory to student tours. Volunteer to talk to the students at your local school. Ask around. I'm sure you can find ways to help educate the next generation. We need young people to be interested in engineering and manufacturing.

I spent several hours with my group at IMTS. We were so busy looking at cool stuff, we didn't even stop for lunch. Best of all, nobody got bored. Unfortunately, we didn't even come close to seeing all that IMTS had to offer. But it's OK, because all four said they want to come back when IMTS returns in two years.

Technology is cool. Spread the word.

Renee Stott, Kate Simone, Matt Stott and Emily Stott, showing off the air-powered rockets they designed and launched at IMTS 2016.

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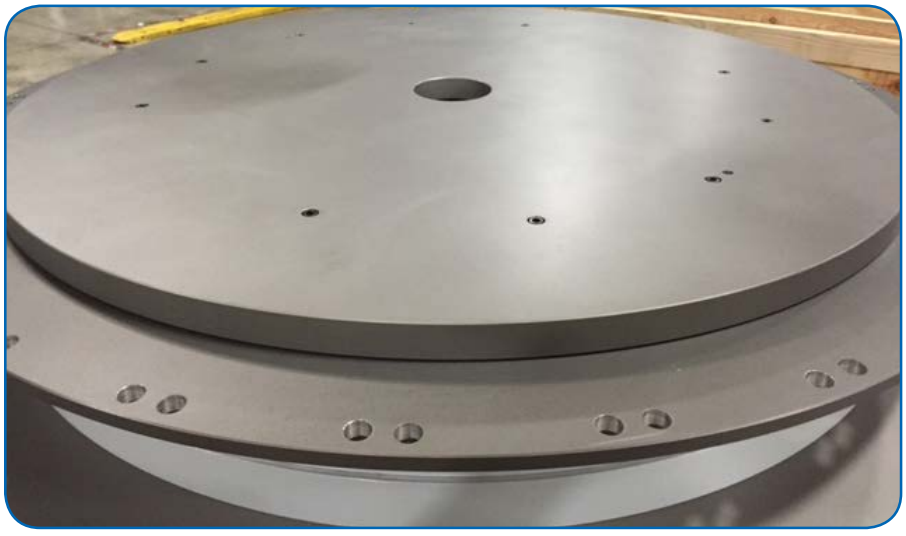
Weiss North America

PROVIDES ONE-STOP SOLUTION FOR MEDICAL PARTS MANUFACTURER

Weiss (Buchen, Germany) and its subsidiary Weiss North America, Inc. (Willoughby, OH), recently completed three, turnkey TR1100, ring-style chassis systems for a leading west-coast medical parts manufacturer. Their client's diverse medical product line provides patients and caregivers safe, innovative, life-enhancing medical devices that help improve patient outcomes by minimizing bacterial ingress that can cause bloodstream infections, and preventing exposure to infectious diseases or hazardous drugs. Their most recent manufacturing challenge was for a closed female luer valve that would require a robust system featuring 24 install stations for a 3–5 piece assembly production process.



Whereas the medical parts client had only a small build shop, they sought out Weiss to provide a one-stop solution that would allow them to maximize efficiencies, while granting them more time to focus on multiple projects. They also desired a quiet, smooth running system for their clean room application.

The key to the Weiss solution involved their TR1100 ring style chassis featuring a ring indexer, stationary plates, and riser. These were all housed in a unique octagon-shaped frame design that is enclosed with a guarding system on the lower half for protective access to controls and mounting automation. Weiss engineers faced the task of building a base machine chassis that can accommodate 24 install stations for a 3-to-5 piece multiple size medical valve assembly process that included: loading, pressing, ultrasonic welding, leak testing, inspection, ejecting, etc. The combination of robust construction of the TR1100 Series System and octagon frame design provided more than enough scope for coupling with the multiple processing stations.

At the heart of the system, the TR1100 Series rotary indexing rings feature a very large central opening (up to 1750 mm possible), extremely flat design, and a high level of parts accuracy. The ring-shaped design allows extra free design space, and the rotating aluminum ring can be adjusted to client's specifications in terms of diameter and thickness.

The TR1100 modified chassis design was based on the client's request for the octagon shaped frame beneath the top plate. This fully enclosed guarding undercarriage system is comprised of a combination of aluminum extrusion and sheet metal fabrications that included six bolt-on panels and two swinging door panels for access to controls. The entire frame was powder coated.

The frame extrusion also needed to be flush with both the top plate and the mount enclosure doors. The index table has a 2" thick aluminum riser,

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the octagon table top is 63" across flats and 1.25" thick. The 48" diameter aluminum dial plate is 1.00" thick and the 44" diameter stationary tool plate is 1.25" thick. All chassis system plates featured a hard coat anodized finish that is essential in providing superior durability.

For mounting automation inside the guarding frame, the medical parts client also requested Weiss to rigidly mount some of their HP70 Pick-and-Place direct-drive components–designed for the application of multiple picks requiring speed and accuracy. The HP70s delivered 70 mm of vertical stroke with 225 mm of horizontal stroke.

The HP70 Pick-and-Place direct-drive component is thinner (60 mm wide) than any linear motor or pneumatic module on the market today. Despite its unique compact design, it surpasses all previous Pick-and-Place units when it comes to speed–achieving over 100 cycles per minute with repeat accuracy of 0.01 mm.

Key to the HP70's design, is a new drive concept that works with two linear motor axes that feature a unique 'knuckle' design on the y/z axis–virtually eliminating the need for another linear motor for the z axis.

The collaboration with Weiss on their 24-station medical luer valve system provided the client with a turn-key solution that exceeded performance goals, while freeing up their time for ongoing multiple production project management. The Weiss engineering group provided a one-source medical parts assembly solution–delivering a 1.25 second index cycle time with an indexing table speed of .33 seconds–from station to station. According to Peter Fiouzi, director of sales-western region at Weiss, "We've completed one chassis so far and have two more currently in production for the client. The two new ones are nearly identical to the first but just a bit larger in configuration scope."

For more information:
Weiss North America, Inc.
Phone: (440) 269-8031
www.weissna.com

Hansford Sensors

PROVIDES FLEXIBLE CABLE ASSEMBLIES

Hansford Sensors has launched two new cable and connector sets for use with its existing range of vibration sensors. The new HS-AC334 and HS-AC335 cable assemblies have been developed for use in applications where IP67 sealing is required, or where vibration sensors have to be used in extreme operating temperatures.

The new cable assemblies are rated for use between –80 and +200 degrees Celsius and are manufactured from FEB (Fluorinated ethylene propylene). This is flexible, robust and provides excellent dielectric strength, making it ideal for a wide range of industrial and process duties.

The HS-AC334 and 335 can be supplied with straight or right-angle two-pin MS connectors, or with three-pin connectors for use with dual output sensors, and are available in a variety of standard or custom built lengths. The new cables are designed for use with most of Hansford Sensors' industrial accelerometers, including the AC, 4–20mA and dual output vibration and temperature sensors.

For more information:
Hansford Sensors
Phone: +44 (0) 845 6801 957
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PI (Physik Instrumente)

RELEASES COMPACT MICRO-TRANSLATION STAGE

PI (Physik Instrumente), a provider of precision motion control and positioning solutions for more than four decades, has released a low-profile motorized positioning stage — the M-122 — with a very small footprint of 60 × 86 mm and a travel range of 25 mm, best suiting it for research and industrial applications including fiber alignment, metrology, quality assurance testing, photonics packaging, test equipment, and micromachining.

The compact closed-loop positioning stage can handle payloads to 11 lbs., with velocity to 20 mm/sec. The optical linear encoder provides 100 nanometers resolution and better linearity and repeatability compared to rotary encoder or stepper motor equipped positioners. Long service life and excellent guiding accuracy with minimal backlash are guaranteed by the preloaded ball-screw drive and precision crossed roller bearings with anti-creep cage assist.

M-122 stages can be combined to create very compact XY and XYZ systems. Combined with the networkable low-cost C-863 Mercury servo motor controller, M-122 stages offer high performance at a competitive price.

To protect equipment, non-contact Hall-effect limit and reference switches are installed. The direction-sensing reference switch supports advanced automation applications with high precision.

For more information:
PI (Physik Instrumente)
Phone: (508) 832-3456
www.pi-usa.us

Steinmeyer

RELEASES XI-PLUS LINE OF BALL SCREWS

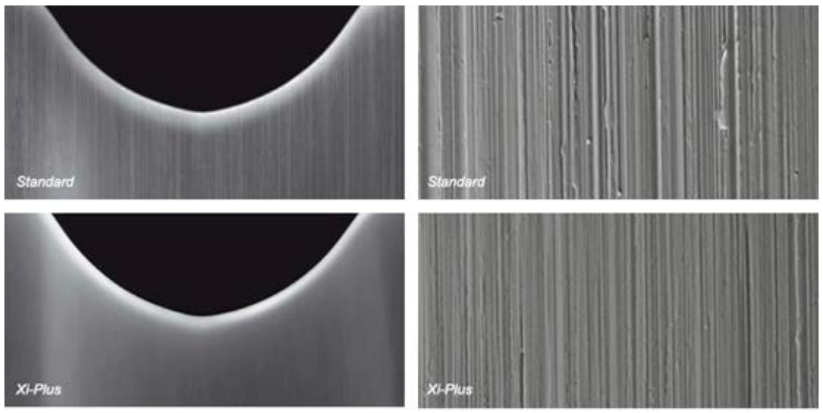
Steinmeyer, a global manufacturer of precision ground ball screws, introduces a new ball screw line called Xi-Plus. These screws feature a smooth raceway surface that achieves significantly quieter operation with reduced vibration for every application.

Xi-Plus precision ball screws are manufactured in Germany like all Steinmeyer products. The ball screws undergo a proprietary finishing process that removes micron-sized defects on the shaft raceway. These defects are responsible for high pitched "whistling" and rough running characteristics.

"Steinmeyer has a long history of delivering linear motion innovations that improve the performance of our customers' systems," stated Bruce Gretz, executive vice president of Steinmeyer, Inc. "Xi-Plus precision ball screws are an outstanding solution for applications that require smooth and quiet operation."

Like all Steinmeyer products, Xi-Plus precision ball screws offer dynamic delivery of linear motion at high standards of precision and longevity. The screws feature shaft diameter between 16–125 mm and all nut styles are available.

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



Before and after scanning electron micrograph (SEM) photographs show the effects of Xi-Plus technology. Left:50X magnification, Right: 1,000X magnification.

Primatics, Inc.

RELEASES HIGH ACCURACY POSITIONING TABLES AND NANO PRECISION STAGES

High accuracy positioning tables and nano precision stages, from Primatics, Inc., are used in applications where high accuracy and repeatability and/or smoothness are critical. All sub-assembly components are machined to very tight tolerances in order to achieve the required accuracy and repeatability. Typical precision for these types of stages are measured in the sub-micron or nanometer range. Precision ground acme screws, precision ground ball screws, or brushless linear motors are typically used as the driving mechanisms for these stages. Precision ground cross roller bearings, ultra-high accuracy square rail bearings, or air bearings are mainly used for the linear bearing system. Granite or a precision machined steel plate is commonly used for the table mounting surface. A temperature controlled environment, machine shock absorbers, and high resolution linear encoders are also usually required in order to obtain and maintain the system accuracy and repeatability over the life

of the product. Primatics custom engineered solutions are ideal for assembly & inspection applications, vacuum environments, clean room environments and metrology applications for precision testing and measurement. The family of linear stages include: PCL50 and PCL65 Linear Stages, PCR32/43 Series Positioning Stages, PLG Stages, PO Series, PXL Stages and more.

For more information:
Primatics
Phone: (541) 791-9678
www.primatics.com

Cortec Corporation

DEVELOPS SUPER BARRIER VERSION OF ITS ECOSHIELD VPCI-144

Cortec Corporation has developed a new Super Barrier version of its EcoShield VpCI-144 paper for protecting metal parts from corrosion. EcoShield VpCI-144 Super Barrier combines the corrosion protection of VpCI paper coating with a high gloss water-based barrier coating that prevents moisture from reaching metal parts wrapped inside the paper. The enhanced moisture barrier of EcoShield VpCI-144 is an excellent environmentally friendly alternative to polyethylene and waxed papers. Under recent ASTM E-96 testing, EcoShield VpCI-144 Super Barrier exhibited a water vapor transfer rate (WVTR) highly comparable to that of polycoated paper.

For more information:
Cortec Corporation
Phone: (651) 429-1100
www.cortecvci.com

Past testing has also shown EcoShield VpCI-144 Super Barrier to rival the moisture barrier properties of poly-coated paper and commercial waxed paper. This is an important advantage since poly and wax coatings are not recyclable through normal channels and therefore create an environmental problem. In contrast, EcoShield VpCI-144 is environmentally safe and fully recyclable into other types of paper products such as boxes, cardboard, and other corrugated materials.

EcoShield VpCI-144 Super Barrier combines corrosion protection, moisture barrier properties, and oil and grease resistivity into one material to protect both ferrous and non-ferrous metals. This eliminates the need to inventory multiple types of papers for different types of metal. Protected metals include carbon steel, stainless steel, galvanized steel, cast iron, aluminum alloys, copper, brass and solder.

VpCIs on the inside face of the EcoShield VpCI-144 Super Barrier paper vaporize and condense on metal surfaces to form a thin protective film that doesn't influence physical properties of most sensitive electrical and electronic components, including conductivity and resistivity. The protective film does not need to be removed prior to further surface finishing or coating application, and protected parts can be painted, welded, or soldered.

EcoShield VpCI-144 is useful in a variety of different applications including metal production, metal forging and die casting, metalworking, finished products and electrical and electronic products.

Zero-Max

CD COUPLINGS OFFER HIGH POWER DENSITY

The quest for smaller machine footprints continues as designers seek new ways to reduce machine size while increasing output. The Zero-Max CD coupling pictured provides precise and reliable shaft connections in less space than other couplings. It operates without fatigue for reliable 24/7 operation required in the latest machine designs.

Key to this CD coupling design is the composite flex element. It provides high torsional stiffness, yet allows for misalignment in high stress applications. In addition, these zero-backlash CD couplings provide smooth operation at high speeds. The coupling's high performance material is configured in a compact design like that pictured surpassing the performance of much longer couplings. The resulting space savings enables machine designers to reduce the foot print saving valuable floor space.

Designed around Zero-Max's unique composite center disc, Compact CD couplings perform at peak torques in the most hostile operating environments — from extreme cold to hot weather conditions –70° to +250°F (–57° to +121°C). Time-proven applications include drive trains, gear boxes and generators providing trouble-free operation in sea water and abrasive desert sand conditions.

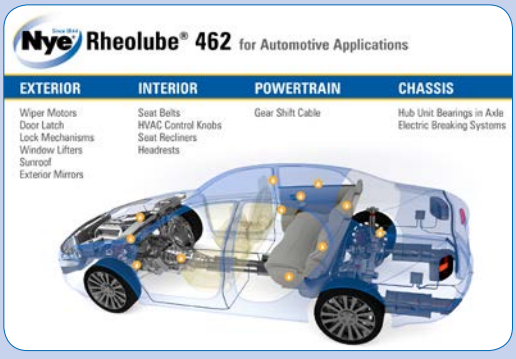
For more information:
Zero-Max
Phone: (800) 533-1731
www.zero-max.com

Nye Lubricants

DEVELOPS RHEOLUBE 460 SERIES

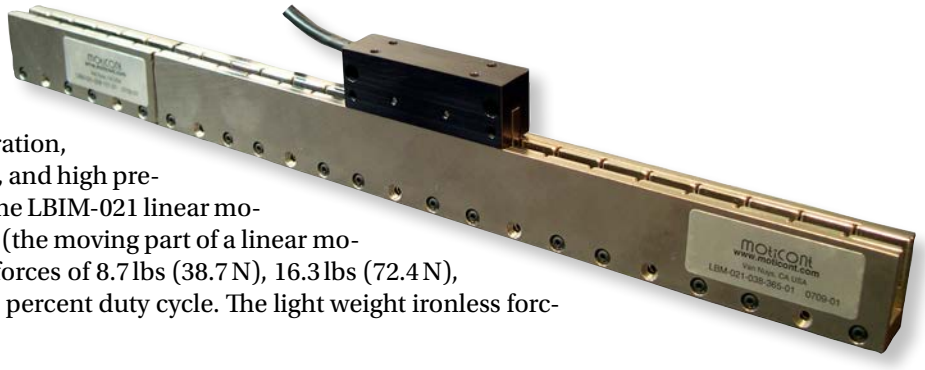
Nye Lubricants is developing the next generation of synthetic hydrocarbon greases thickened with lithium soap. These new greases are the Rheolube 460 series, an improved version of Nye's 360 series. The greases demonstrate improved load carrying ability and anti-wear performance. They have excellent oxidative stability and superior corrosion resistance.

The first grease in the series has been formulated and commercialized as Rheolube 462. The new grease improves on our current Rheolube 362HT product successfully used for many years in the automotive industry. Rheolube 462 has been designed for low-temperature applications exceeding the OEM requirement of –40°C. The grease has a long service life due to its resistance to ageing and oxidation. It provides improved wear protection, outstanding



Moticont Servo Motors

FIT A VARIETY OF LINEAR MOTION APPLICATIONS



The off-the-shelf, LBIM-021 series of linear three-phase brushless servo motors from Moticont are sized to fit a broad range of linear motion applications. These low cost, compact linear motors feature: High acceleration, high speed, high accuracy, high repeatability, and high precision to less than one micron (0.00004 in.). The LBIM-021 linear motor series is comprised of four sizes of forcers (the moving part of a linear motor) and matching magnetic tracks creating forces of 8.7 lbs (38.7 N), 16.3 lbs (72.4 N), 23.1 lbs (102.9 N), and 31.0 lbs (138.1 N) at 10 percent duty cycle. The light weight ironless forcers have no iron providing high acceleration, low inertia, and cog free motion. These high speed, non-contact brushless linear motors are ideal for a variety of: Medical, manufacturing, scanning, inspection, laser cutting, and precision assembly applications.

Clean room and people friendly, these clean, non-commutated, quiet linear servo motors are easily integrated into new and existing applications.

For more information:
Moticont
Phone: (888) 785-1804
www.moticont.com

corrosion protection in salt water, and excellent water resistance. The product contains a UV indicator that allows quality checking.

This advanced Nye technology offers advantages in applications such as rolling bearings for small motors, sliding surfaces, geartrains, switch gears, and electrical components such as window lifters, sun roofs, seats and fan flaps. The grease can also be used on many plastic/plastic gears or plastic/metal combinations.

For more information:
Nye Lubricants
Phone: (508) 996-6721
www.nyelubricants.com

ETEL

PRESENTS TMB+ SERIES IN NORTH AMERICA

ETEL unveiled the newest advancement of their torque motor family, the TMB+, during IMTS 2016. In order to keep up with the high demands of the machine tool market, ETEL has taken its existing TMB line of torque motors and redefined it to increase its overall torque, size selection, and winding options to expand upon an already extensive and well renowned series of direct drive motors.

The TMB+ is fully pin-to-pin compatible with the TMB series but offers an increased performance of up to 22 percent continuous torque and up to 4 percent on top of its already high peak torque. Also the TMB+ has reduced power losses, four different winding options per size and a new 200 mm active length for each diameter, increasing its overall size selection from the TMB. These options help propel ETEL torque motors beyond the competition and pushes towards the goal of making direct drive technology as accessible as possible.

The TMB+ series comes in 62 standard model sizes with four different windings each, allowing the user to get maximum performance depending on how much torque, current, and speed needs is required. TMB+ motors can achieve a peak torque of up to 42,900 Nm and utilize flux weakening to increase it is speed capabilities. It also has the option of coming with ETEL's IMTHP thermal module which, when coupled with ETEL's torque motors, enables users to reduce their amount of safety margins while receiving precise and reliable temperature monitoring. ETEL torque motors are compatible with most CNC controllers.

The TMB+ series is designed specifically for direct-drive applications and offers the following advantages over transmission-based devices: fewer parts, requiring lower overall costs; maintenance-free operation; no backlash, allowing for better accuracy and repeatability; smooth, precise and efficient motions; and compact design.

For more information:
ETEL Motion Technology (Heidenhain)
Phone: (847) 755-5569
www.etelusa.com

SKF

CENTRALIZES SOLID OIL BEARING PRODUCTION

SKF has centralized the production of bearings with Solid Oil to promote timely delivery throughout North America and has introduced enhanced formulas to benefit more applications across industries. These bearings are filled with an oil-saturated polymer matrix, which creates a consistent lubricant supply able to withstand very cold temperatures (down to –65°F and –53°C), aggressive chemicals, contaminants, and high centrifugal forces. The polymer matrix contains two- to four-times more lubricating oil than standard grease-filled bearings and the bearings never have to be re-lubricated. As a result, maintenance lubrication challenges are eliminated, especially benefiting applications where the accessibility to manually lubricate bearings is unsafe, impractical, and/or impossible.

SKF manufacturing capabilities for bearings with Solid Oil have been newly housed at the strategically located SKF Solution Factory in Cleveland, OH, resulting in advanced production and quicker delivery timelines anywhere in the USA and Canada. Virtually any standard SKF bearing type (including stainless steel) can be equipped with Solid Oil, which both provides required lubricant to a bearing and acts as an extremely effective seal by completely filling a bearing's cavity. Seals for lubricant retention become unnecessary.

The enhanced portfolio of Solid Oil formulas expands bearing solutions for the most critical and formidable applications. These include food processing equipment (with two NSF H1 registered compounds available), cranes, machinery, and conveyors where manual greasing would raise safety issues, and any application subjected to dirt or humidity, aggressive chemicals, extreme contamination and/or other adverse conditions that could jeopardize conventional lubricant.

A variety of additives, such as rust inhibitors, can be specified into the mix for increased protection and customized product solutions can be developed to meet especially demanding requirements.

For more information:
SKF USA Inc.
Phone: (267) 436-6772
www.skfusa.com

Taking Aim at Conveyor Systems

Gearmotor manufacturers are finding new ways to appeal to the conveyor systems market.

Alex Cannella, News Editor

It's no secret that conveyor systems are the primary market for gearmotors, and so it shouldn't be much of a surprise that gearmotor manufacturers are looking for ways to cater to that market's needs. From Brother's new VFDs to Siemens' Simotics S-1FG1, a lot of the new solutions in the industry have their own unique quirks, but all fall into a few common veins.

Unsurprisingly, one of the main focuses is efficiency. Between tightening mandates and the European race for ever more efficient motors, energy efficiency has been a buzzword for a few years now.

What is a bit of a shock, however, is that premium (IE3) motors are still not the de facto standard. Back in June, the DOE again expanded the range of motors now required to be at a minimum premium efficiency. One might expect that in the wake of the most recent rules change (which is the latest of a long line of tightening efficiency restrictions on the industry), premium motors would have become old hat, the new standard everyone expects. But four months later, gearmotor manufacturers are still running into customers that never got the memo and premium efficiency is still an important selling point, not the baseline expectation, even though in many cases, it's the lowest efficiency legally available on the market now. The most recent mandate has been in effect for some time now, but it's still very much an issue affecting the industry.

"Sometimes people that are in the market, we just take it for granted that everybody knows about it," Matthew Roberson, senior director of Brother's gearmotor division, said. "And quite honestly, they don't... There still seems to be an educational gap between the regulations and what they mean to equipment manufacturers."

"A lot of our customers heard something about them launching [the new law], but they weren't really sure how it affected them," Tom Koren, Nord's engineering manager, said. "So we have to go out and educate our customers on what changes we have to make and how it's going to affect their product."

Many manufacturers are still working to get all their customers onboard and overhaul their inventories. Some of the industry's newest innovations are also focused on delivering higher efficiencies without adding weight or size to the motor, and even outside the new law, full system efficiency is becoming an increasing focus.

Another common theme is standardization. A common issue many gearmotor manufacturers are trying to address is the laundry list of different gearmotors many end users have built into their systems. Currently, many of these gearmotors aren't quite redundant, but they all have slight variations required based on multiple required speeds, sizes or configurations, which leads to a bloated inventory of numerous, slightly different gearmotors all built into a single system. Gearmotor manufacturers are focusing on making more versatile products that can cut down on the number of different gearmotors required to make a given system run. Having more one-size-fits-all gearmotors simplifies the task of finding the right tools for the job and, more importantly, makes maintenance and upkeep easier.

Brother Gearmotors: Bringing Expertise to the Subfractional Market

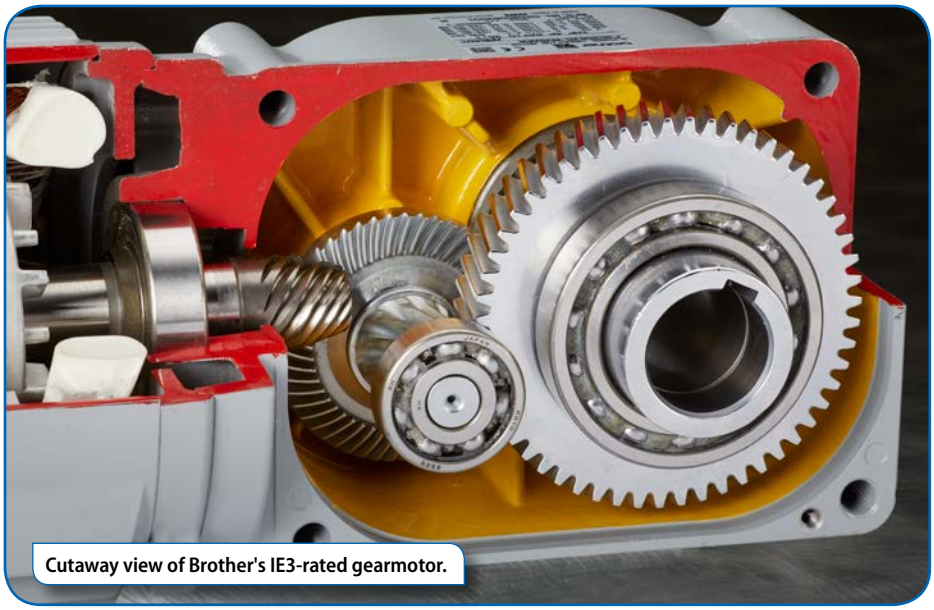
The newest product Brother Gearmotors released just this month stems from a recent partnership between Brother and American Control Electronics (ACE), Variable-Frequency Drives that are specifically designed for use with subfractional motors.

The VFDs' main selling point (beyond their compatibility with subfractional motors) is their speed control, which allows OEMs to use three-phase motors where normally only single phase power is available and offer higher starting torque and running efficiency. Other control features include injection braking, acceleration and deceleration control, a torque limiter, motor overload protection and overheat protection.

ACE's VFDs target a currently underserved industry. According to Roberson, subfractional motor OEMs don't have many options for finding a VFD, and so they often resort to using an oversized VFD, which means reduced efficiency, a larger end product and other headaches.

"What we've found here is that there are a lot of people who need electronic control on small horsepower, but there's not a lot of VFDs on the market for those subfractionals," Roberson said. "So what they actually do, is they oversize it. They're buying VFDs that are really for 1-3 hp and using them on subfractionals and they're just not a match optimally...With our product, it's more optimized in design for just that specific subfractional product."

Brother has also recently introduced their own IE3 premium motor line. On top of meeting premium efficiency requirements, many of Brother's company-wide features can be found in their premium motors. According to Roberson, their production method,



Cutaway view of Brother's IE3-rated gearmotor.

which they execute from start to finish, is part of what sets Brother's gearmotors apart.

"We've got five factories in Japan, and raw materials come into these factories and gearmotors come out. And there's not a lot of companies that do this. That means we wind all of our own gearmotors, we stamp all of our own laminates, we make all of our own shafting and gearing, we do all of our own heat treat, we do all of our own die casting, we do all of our machine work, we do all of our own electrostatic painting."

Another advantage of Brother's gearmotors is that they're all lubricated with grease instead of oil. This allows the gearmotor to forgo installing any breathers, which oil-lubricated gearmotors need to allow heat to escape the machine. This, in turn, allows Brother's gearmotors to be universally mounted and lets the end user trim down on the number of different gearmotors they need to buy.

"Let's say you're an OEM and you have a gearbox on the right side of the conveyor, and the same gearbox on the left side of the conveyor," Roberson said. "If you're using someone else with oil, you're probably buying two different gearboxes, and your inventories would be doubled. With our universal mount, you can have one gearbox that would flip, and customers really like that."

Lenze: Standardizing Conveyor Systems

Headlining Lenze's latest products is their g500 gearbox, and according to Alby King, Lenze's electromechanical product manager, this one's a doozy.

"On the gearing side, the g500 is easily the biggest thing Lenze has done in its entire history," King said.

The g500's primary feature is its motor input interface. The interface between different motors and the g500 is the same size, making it possible to easily mix and match different models. As a bonus, having a one-size-fits-all interface removes the need for an adapter plate. This, in turn, trickles down further benefits, such as a lower oil temperature and improved sealing properties. Without an adapter plate, the g500 only has an o-ring sealing the connection between motor and gearbox, which is actually an improvement over the gasket and plate, and with the adapter plate out of the way, Lenze's motors blow air on the gearbox, lowering the temperature of the oil enough for end users to see up to a 50 percent increase in lubrication longevity.

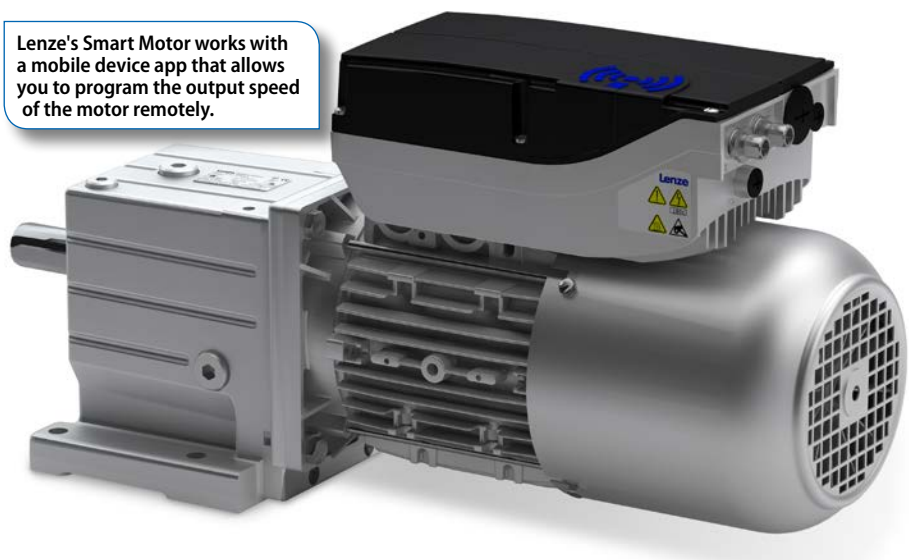
"It's not very many degrees, but it makes a big difference," King said.

Another big product to recently come out of Lenze is the Smart Motor, a motor that's set up to work with a phone app that can program the output speed of the motor. The product mainly targets conveyor systems, allowing them to cut down on the number of motors they need to have on hand and standardize their system.

"Conveyor belters purchase multiple gearmotor configurations to accommodate multiple payloads and velocities," King said. "What the Smart Motor does is it allows you to reduce the number of different configurations due to the fact that you can program the output speed with a phone."

The Smart Motor has five different configurable speeds (including a reverse) and works at speeds ranging from 500 to 2,600 rpm.

The g500 and Smart Motor are also compatible with each other, combining as a single package to deliver quality system efficiency. Together, the Smart Motor and g500 set themselves up as a versatile product that can fulfill a broad range of conveyor applications, eliminating the need for multiple motor configurations and standardizing conveyor systems while providing



Lenze's Smart Motor works with a mobile device app that allows you to program the output speed of the motor remotely.

energy efficiency concurrent with the latest energy mandates.

"You can take a dozen different gearmotors and bring it down to two in the end," King said.

Nord: Doubling Down on System Efficiency

While companies such as Brother might deliver on full system efficiency options, Nord doubles down on it and has made the topic their entire focus. They're all about providing the highest system efficiency possible to ensure the customer gets the most out of their energy savings.

"The industry's been pushed into these premium efficiency motors by government regulation," Koren said. "And then they still allow you to bolt that premium efficiency motor onto a 50, 60, or 70 percent efficiency worm gear. And it just doesn't make sense. What Nord's invested all their energy and time and money in is really making complete optimized selections. We don't look at motors. We don't look at gearboxes. We look at gearmotors. We look at them as a system and developing the most energy efficient system that we can provide, including the control."

Full system efficiency is currently a bit of a blind spot in the motor industry as a whole. While motors themselves are growing more efficient every year even beyond tightening regulations, many of the products they get bolted to have little to no regulation on their energy efficiency, and you start running into situations where hyper-efficient motors are somewhat squandered because they're attached to inefficient products that essentially drag down the team.

The DOE is currently making the rounds and looking at some of the larger systems motors are used in (such as pumps, for a recent example) and setting new energy standards, but with so many different systems to look at, it's like playing a game of whack-a-mole, and there's no telling how many different systems the DOE will ultimately shine a light on or how long it will take. While motor efficiency has seen a massive push in the last decade, full system efficiency is lagging behind in both quality and awareness. Nord is one of the few companies actively focusing on reversing that trend, focusing on superior energy efficiency across the board as opposed to pushing the limits of motor efficiency with IE5 motors.

A primary example of this is their 92.1 two-stage helical bevel gearbox, which features an average efficiency of 97 percent. The 92.1 also boasts a 70:1 gear ratio, another trait that, according to Koren, sets Nord's products apart from the competition.

"Nord Gear cuts pinion gears on our motor shafts, which allows us to get up to roughly a 70:1 gear ratio in a two-stage product," Koren said. "So what this product can often do is replace worm gears that maybe operate at 50, 60, 70 percent efficiency. We can replace something in approximately the same footprint that operates at 97 percent efficiency."

It's important to highlight that Nord's method not only allows for high system efficiency, but also does it without making the gearmotor larger. Usually, in order to improve efficiency (most commonly by just putting more copper into the motor), a manufacturer makes the motor larger and/or heavier in the process, but Nord's process allows them to minimize that increase in size.

Running in a similar vein, the 92.1 also features large bore and shaft capacity, which prevents OEMs from having to use oversized gearmotors to accomplish tasks. The 92.1 has high overhung capacity load and its housing is machined using the Unicase one-piece housing design.

In general, Nord's solutions also have some benefits when it comes to standardization. Due to the aforementioned pinion gears cut directly on the motor shaft, Nord is able to homogenize their line of motors without losing efficiency or power. Nord only manufactures 4-pole gearmotors, but according to Koren, their gearmotors can also reach the same output speeds as other companies' 6-pole motors would, which trims down on the number of different models end users need to order to make their system run.

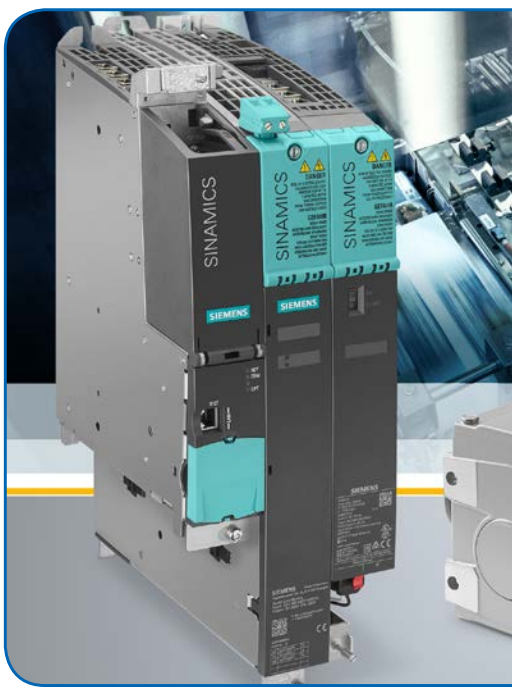
"You have different motors at different speeds, and the programming for those motors is different," Koren said. "It creates a lot of headaches for people in the industry to have different motors just to get different output speeds on a gearbox. Nord's 1 hp motor is always a 1,800 rpm base speed 4-pole motor, no matter what output speed you're buying."

Nord has also made a recent push into large industrial motors with the Maxxdrive, a large gearbox that can be assembled as either a right angle bevel or parallel shaft and can support loads up to 2.2 million lb-in of torque and reach up to almost 1,300 hp. It's a new market for Nord, but according to Koren, they're seeing active interest in the Maxxdrive.

"We're not known for that product," Koren said. "Nord is known as being one of the global leaders in the small gearmotor business. We're working to develop our reputation and name in the large industrial gear market. It's going well for us."

Siemens: Servicing the Industry with Servomotors

The newest gearmotor to come from Siemens is the Simotics S-1FG1, a permanent magnet servo gearmotor, which Siemens has designed to work with their S120 drives. The 1FG1 offers a number of features, including multiple gearbox options (helical, parallel shaft, bevel and helical worm) to meet different applications. Siemens's article also features up to 25 different gear ratios.



According to Summervill, however, the 1FG1's distinguishing feature is that its encoder is decoupled from the output shaft. With this setup, the encoder endures fewer vibrations and less heat, two primary causes of encoder failure, thus improving its lifespan. But even if the encoder fails, having it decoupled from the output shaft allows maintenance staff to swap it out for a new one, as opposed to having to send it back to the manufacturer to repair.

The removal process is simple and can be done in minutes as opposed to the days shipping the motor to the manufacturer could take. Just unbolt the failed encoder, take it out and replace it with the new one, which can slot directly into a keyway.

"It's just like a key in a car," Summervill said.

The 1FG1 also forgoes putting an adapter plate between the gearbox and motor, instead using a plug on pinion. This reduces the length and weight of the servomotor.

Summervill has noticed a growing trend of customers moving towards servomotors that has been fed by many of the same advantages highlighted in the 1FG1. Products such as the 1FG1 speak to those always looking for ways to save money and improve productivity, as it not only saves space and time, but also offers potential energy savings, all of which can lower the cost of operation. According to Summervill, servomotors are generally a little more efficient than premium motors. While they're not as efficient as Siemens' standard super premium/IE4 motor offerings (which you could, of course, add a gearbox to yourself), they still do offer a slight edge over current standard offerings, and that edge still means saving on the energy bill.

Siemens Simotics S-1FG1 servo gearmotors feature an encoder that's decoupled from the output shaft, providing for longer life.

For more information:

Brother Gearmotor
(866) 523-6283
www.brother-usa.com

Lenze
(508) 278-9100
www.lenze.com

Nord Drivesystems
(608) 849-7300
www.nord.com

Siemens
(800) 743-6367
www.siemens.com/us/en/home.htm

Pack Expo 2016

(What You Need to Know Before You Go)

Matthew Jaster, Senior Editor

Pack Expo takes place November 6-9 at McCormick Place in Chicago. With 2,100 exhibitors, it's the world's largest most comprehensive processing and packaging trade show in 2016. The expo includes full-scale machinery in action as well as new packaging technologies, solutions for 40+ vertical markets, free educational opportunities (Innovation Stage, Food Safety Summit Resource Center and the Reusable Packaging Learning Center). Pack Expo features four international pavilions including the Containers and Materials Pavilion, the Confectionery Pavilion, the Processing Zone and the Reusable Packaging Pavilion. Show hours are Sunday, November 6 through Tuesday November 8 from 9:00 am to 5:00 pm and Wednesday, November 9 from 9:00 am to 3:00 pm. Pack Expo International offers attendees the chance to see technologies in motion, meet with packaging suppliers, explore technology for their industry and get ideas from other markets, including automotive, food and beverage, hardware, household products, metals, paper, pharma, textiles and more.

Co-located with Pharma Expo

Pharma Expo offers pharma, biopharma, medical device, personal care and nutraceutical manufacturing professionals a premier tradeshow experience. Attendees will see technology, equipment and machinery in action from over 250 top-tier suppliers serving the pharmaceutical supply chain, learn about the latest breakthroughs from technology suppliers right on the show floor and in free seminars at the Innovation Stage, and network and talk shop with 10,000+ industry peers—and another 45,000+ processing and packaging professionals at Pack Expo International. The Pharma Expo Innovation Stage will feature 12 sessions while the Pharma Packaging track will feature five sessions.

Education Spotlight

Here is a sample list of educational sessions that may be of interest to *PTE* readers during the show:

- "How the Industrial Internet of Things (IIoT) Provides a Critical Competitive Edge in Manufacturing." *Monday, November 7 10:00–10:30, Presented by Paul Boris, GE Digital*
- "Safety Performance Requirements for Modern Scalable Machines." *Monday, November 7 1:00–1:30, Presented by Sari Germanos, B&R Industrial Automation*
- "Remote Monitoring." *Monday, November 7 1:00–1:30, Presented by Doug Weber, Rockwell Automation*
- "Advances in Chain Technology Provide Solutions for a Variety of Problems Commonly Found in the Food Packaging Industry." *Monday, November 7 3:00–3:30, Presented by Aimee Ray, Renold Jeffrey*
- "Building a Smarter Machine." *Tuesday, November 8 10:00–10:30, Presented by Steve Mulder, Rockwell Automation*
- "Getting Connected: The Importance of Visibility on the Plant Floor." *Tuesday, November 8 11:00–11:30, Presented by Paul Boris, GE Digital*
- "Creating a Positive Consumer Experience: How to Leverage the Benefits of Ultrasonic Technology in Packaging." *Tuesday, November 8 12:00–12:30, Presented by Hans Neisser, Emerson*
- "Cloud-Connected Industry Powers Continuous Improvement." *Tuesday, November 8 1:00 -1:30, Presented by Daymon Thompson, Beckhoff Automation*
- "A Progressive, Simple and Rapid Approach to Boost Small and Medium-Size Manufacturing Companies Operational Efficiency and Reach Smart Factory … Connect, Monitor, Improve." *Tuesday, November 8 3:00–3:30, Presented by Marc Vermette, Worximity Technologies Inc.*
- "Machine Performance, OEE and IIoT Connectivity Made Easy." *Wednesday, November 9 11:00–11:30, Presented by Lucian Fogoros, Schneider Electric*

Pack Expo Booth Previews

Siemens Industry Inc. (N-4941)

Siemens recently announced the immediate availability of its popular Sinamics G120C drive in AA size, which replaces the previous G120C frame size A in power ratings up to 2.2 kW (3 hp), including communication variants for USS, PROFIBUS, PROFINET and EtherNet/IP. Offering high power density in a smaller footprint, the new "tiny drive" offers a fully compatible replacement for the equivalent power ratings on the previous version.

On new control cabinet designs, the G120C FSAA has significant size advantages, up to 32% less overall volume, for the OEM or integrator, but requires no re-engineering, when migrating from the G120C FSA on current jobs. Overall dimensions on the smaller unit, designed for use with PROFIBUS and USS variants, are only 173 mm high × 73 mm wide × 155 mm deep (6.8" × 2.8" × 6.1").

Other benefits of the new G120C FSAA include use with increased motor cable lengths, up to 50 m (165 ft) for shielded

and 150 m (495 ft) for unshielded, plus identical voltage ratings, current ratings, load cycles and compatibility with all standard Siemens options such as operator panels, input and output chokes, as well as external Class B EMC filters. The G120C FSAA offers UL open type, IP20 protection in the 0.55–2.2 kW (0.75–3 hp) range.

Siemens new Simatic S7-1511C and S7-1512C compact controllers combine an S7-1500 CPU with digital/analog IO and technology built into the hardware delivering a cost effective and space saving design.

The latest additions to Siemens popular S7-1500 controller family feature exceptionally- compact designs, making them ideal for production machine applications. The S7-1511C controller is just 85 millimeters wide and offers 32 digital IO ports. The S7-1512C includes 64 digital IO connections and is only 110 millimeters wide. Expandable with signal modules, the S7-1511C has a bit performance of 60 ns and the S7-1512C is 48 ns.

Both compact CPUs include standard S7-1500 design features such as built in display, two port PROFINET connection, integrated Web server and standard S7-1500 internal functionality.

Engineered with Siemens TIA Portal, the controllers offer all the standard S7-1500 high-performance functions, including variant management, automatic address adjustment and option handling. Key technology functions such as metering, measuring, and positioning are already integrated into the hardware.

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

Baldor Electric Co. (E-6704)

Here are a few products and technologies Baldor will be highlighting during the show:

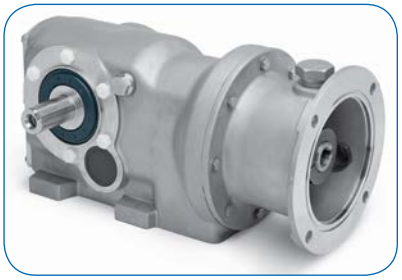
Washdown Duty Motors

Baldor offers the widest variety of washdown duty motors available from stock. Better performance and reliability are the inspirations behind Baldor's new and improved wash-

down duty motors. This was accomplished by adding features like an improved paint system, Baldor's Inverter Spike Resistant insulation system, Class F insulation with Class B (or lower) temperature rise, Mobil Polyrex EM grease, customer-friendly drain plugs, and shaft seals. SSE motors feature all stainless steel construction provide superior protection against high pressure cleaning with features for reliable operation and low cost of ownership.

Ultra Kleen Gearing and Bearings

Ultra Kleen gear reducers feature a totally enclosed ventless sealing system containing a factory filled synthetic lubricant that eliminates the need for routine oil changes. The Ultra Kleen Quantis and Tigear-2 are capable of withstanding high pressure washdowns with caustic chemicals and the ideal solutions for food handling industrial applications.



Ultra Kleen ball bearings feature a stainless steel insert available in both polymer and stainless steel housings. The insert includes the patented QuadGuard seal and Maxlife cage which protects the bearing in extremely harsh environments and provides extended life. The combination of corrosion resistant features and advanced sealing make the Ultra Kleen bearing suitable for demanding applications found in the food and beverage industry. The Ultra Kleen ball bearing received the first Manufacturer Excellence Award presented by the Bearing Specialists Association (BSA) for innovation and excellence in product design and technology.

Baldor Dodge Raptor Coupling

The Baldor Dodge Raptor coupling, with patented WingLock technology, features a finite-element optimized winged elastomeric element design. The Raptor provides longer driven equipment life and improved reliability. Raptor's patented WingLock technology increases surface area at the most critical regions of the element, resulting in higher bond strength, improved fatigue resistance, and longer life than competitive urethane designs. A non-lubricated natural rubber element results in lower stiffness, improved vibration damping, and industry leading misalignment capabilities.

For reduced maintenance, the Raptor offers a split element for easy installation and replacement without moving or re-aligning connected equipment. Slotted clamp ring holes offer extra clearance for mounting hardware, resulting in a noticeably easier installation. Designed for drop-in interchangeability, Raptor couplings work in existing applications without any modifications.

Suitable for a broad range of industrial applications, Baldor Dodge Raptor couplings are third-party ATEX certified for use in hazardous environments. Raptor elements are also available with an Armored Element that exceeds ASTM 1149-07 rubber deterioration standards for use in extreme environments.

ABB Servo Motors

Offering a variety of AC and DC servo motors for industrial, automated applications designed for durability in harsh environments, the company also provides a wide choice of high or low inertia motors with winding options, feedback devices and gearheads to match.

For more information:
Baldor Electric Co.
Phone: (479) 646-4711
www.baldor.com

Regal Power Transmission Solutions (N-4746)

Regal, a manufacturer of electric motors, electrical motion controls, power generation and power transmission components, will debut its MODSORT modular transfer and diverter station in their booth (N-4746) during Pack Expo International 2016 in Chicago beginning November 6. This new transfer eliminates the need for a lift or pneumatics and can be easily integrated into new or existing material handling systems with the ability to transfer a wide array of products.

The MODSORT station features the System Plast 2253RT

roller top belt, which allows it to uniquely transfer and divert packages based on the sphere's vector speed and direction while also featuring a 1-inch, on-center sphere array to allow for very small packages to be diverted. The station can divert on the fly or stop and divert at a true 90-degree angle, and is ideal for polybags and small packages while also easily handling boxes.

MODSORT stations can be placed end to end to create a medium-rate sorter or integrated with conveyors to create transfer stations within conveyor systems. Customization is possible for picking and packing stations within the modern distribution center. Additionally, retrofitting the station into existing conveyor systems is also possible.

Additionally, the company will feature SyMax variable-speed motors from Marathon Motors. These motors exceed European IE4 efficiency levels and the permanent-magnet design is exceptionally power dense, resulting in a 2–3× frame size reduction. SyMax motors minimize energy re-

quirements with an optimized fan design, precision-wound stator, and elimination

of rotor conductor losses. Capable of constant torque over a wide speed range, SyMax motors can be combined with HERA reducers for gear motors with double the torque density and a lower cost-to-torque ratio than standard systems. They are a drop-in replacement for induction motors, utilizing the same footprint, shaft height and other IEC/NEMA dimensions.

For more information:
Regal Power Transmission Solutions
Phone: (859) 727-5271
www.regalpts.com

Fenner Drives (E-9701)

Eagle SureConnect, an innovation from Fenner Drives, radically reduces the complexity of installing polyurethane belting—slashing downtime and associated labor costs. Countless industrial and manufacturing processes rely on uninterrupted service from conveyors. In the past, broken belts meant lengthy line interruptions while a trained welder carried out repairs and the weld cured, sometimes inadequately. Meanwhile, productivity suffered. If a belt isn't adequately welded and cured, premature failure is likely to result. Many lines operate with four or six belts, so the potential for costly downtime is multiplied.

Eagle SureConnect enables lines to be properly repaired and returned to service in approximately five minutes, in contrast to almost 40 minutes with traditional welding . The system relies on a patentpending flexible connector and unique matching polyurethane belting. Two belt ends are joined together simply by twisting in a threaded connector, providing a strong, consistent, sure connection every time. Because welding isn't needed, users can save the purchase of welding equipment and eliminate the need to bring in a skilled welder when a conveyor belt breaks. Anyone on the maintenance staff can handle the repair immediately; extensive welding training is not required.

"The Eagle SureConnect takes belt repairs from an art to a science," said Tyson Gabler, Fenner Drives product manager. "Performance-wise, it's at least as good as the old way of doing things, just as strong and long-lasting. Eagle SureConnect gives the confidence that welds are done right every time." The new system has received rigorous flex fatigue, tensile strength and elasticity testing to ensure performance in any standard welded belt application.

For more information:
Fenner Drives, Inc.
Phone: (717) 665-2421
www.fennerdrives.com

What's Next in 2017? With little more than a year to go, the 2017 installment of Pack Expo Las Vegas and Healthcare Packaging EXPO (Sept. 25–27; Las Vegas) is already positioned to surpass its 2015 numbers, according to Pack Expo producer, PMMI, The Association for the Packaging and Processing Technologies. At the completion of exhibitor booth selection, Pack Expo Las Vegas is up 10 percent with nearly 700,000 nsf sold and Healthcare Packaging Expo is up 20 percent, compared to this same number of weeks out in 2015. The show is expected to be a sold-out event with 2,000+ exhibiting companies.

According to 2015 show statistics, 86 percent of attendees recommend, influence or make the final buying decision in the purchasing process.

With an expected 30,000 attendees in search of new innovations and technologies in the packaging industry, Pack Expo Las Vegas will showcase key products and decision makers.

"We're very encouraged by the number of exhibitors that have already secured booth space at Pack Expo Las Vegas and Healthcare Packaging Expo 2017," says Charles D. Yuska, president and CEO of PMMI.

"It demonstrates the value the show delivers to exhibitors in the packaging supply chain."

Pack Expo Las Vegas will host top CPGs from around the world, providing a wealth of opportunities for exhibitors to connect with potential buyers. Beyond the technologies exhibited on the show floor, attendees will find tremendous value in the wide array of educational opportunities to round out their Pack Expo experience.

Booth space is now available on a first-come, first-served basis — and selling fast. **PTE**

For more information:
PMMI
Phone: (571) 612-3200
www.packexpolasvegas.com

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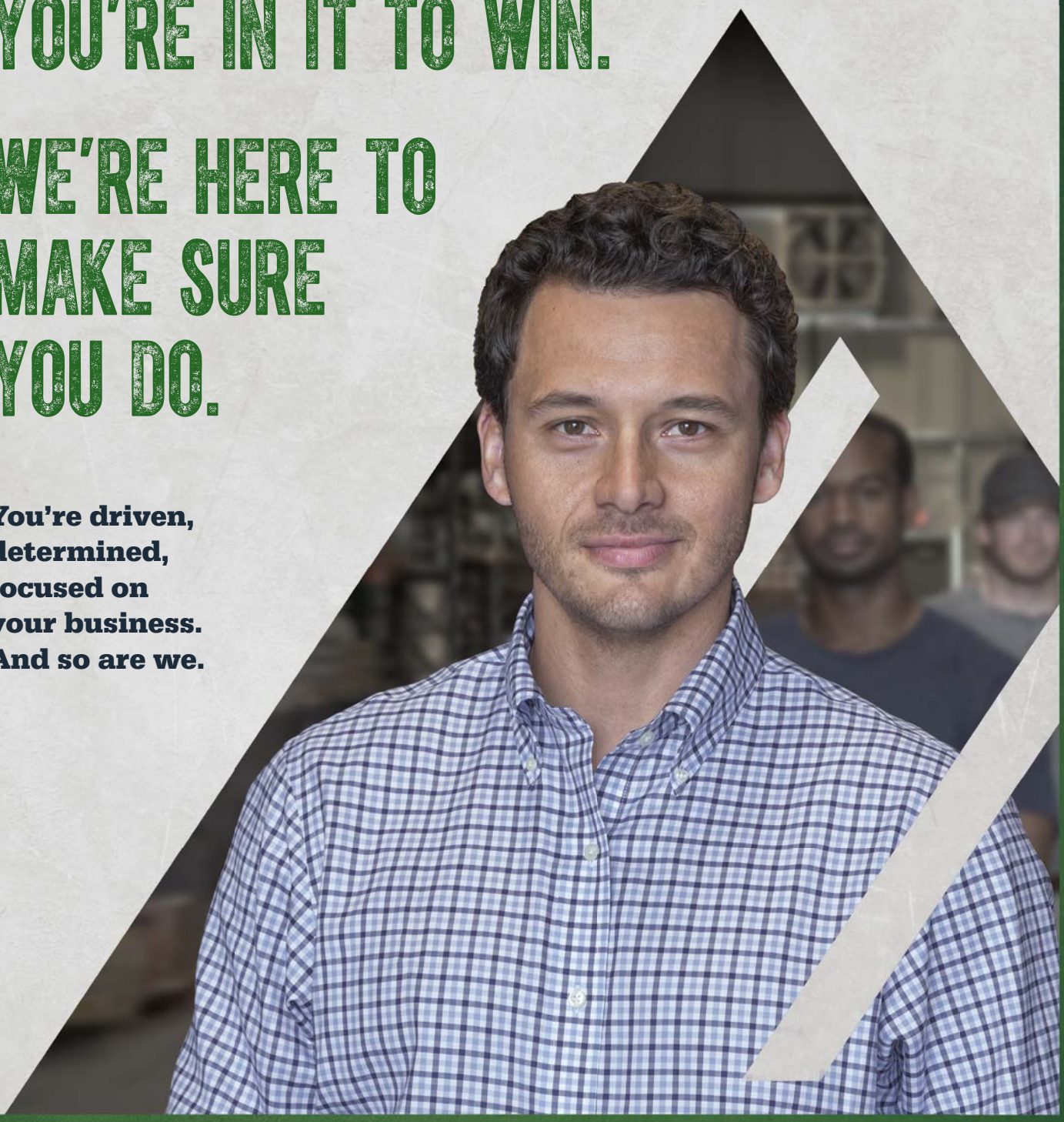

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Special Modifications

Certified Bearing Specialist Solves Bearing Issue on Automatic Cutter for Tissue Rolls

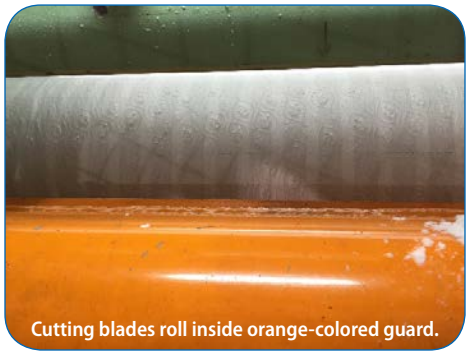
Eddy Swiben, branch manager at BDI Canada, explains how to problem solve on an automatic cutter for tissue rolls.

"This is a very major paper tissue manufacturer that sells paper tissue rolls all over America." They roll paper tissue just like newsprint paper mills do. When the product is finally done and dried, they need to roll it on a light carton core 20-ft. long.

Machine for rolling and cutting paper tissue.

It is then separated from the feeding roll and has to be cut every 4 in. in order to fit any domestic bathroom tissue roll holders.

To do so, a second, 20-ft. long shaft carrying blade discs every 4 in. standing under the first tissue roll is then automatically coupled to a small drive on the side of the machine through a linear and a rotary motion.



Cutting blades roll inside orange-colored guard.

The reason why it has to be coupled and uncoupled is because space is needed for the feeding roll to feed the enrolling roll without the paper coming in contact with the cutting blades.

The linear motion is needed to couple the shaft carrying the blade discs while the rotary motion is needed to roll the blades on the 20-ft. long tissue roll in order to cut 4 in. rolls.

The manufacturer of the machine understood that the load to be controlled on the stub driving shaft was mostly axial.

Considering the fact that a very slight misalignment might occur during the stroking motion, he chose to install a Double Effect 543 series thrust ball bearing with sphered housing washer.

The OEM considered that the balls of the bearing were going to control the axial load against the sphered thrust washers and took for granted that once coupled, the bearings of the 20-ft. roll would support the end of the driving shaft. He underestimated, however, the radial load to carry, as this bearing design cannot accept any radial load. It will work for a while, but not as it is supposed to.

He also considered that the sphered housing washer was going to cope with the slight misalignment (the bushing he installed at the other end of the driving shaft was to keep the linear motion mostly straight). Again, he was almost right, but bushings can wear in a short period of time.

Standing beside the machine for so long, I realized that all of his thinking was okay with a small exception: The sphered thrust washers cannot cope with an excess of misalignment caused by the bushing wear at the other end of the driving shaft.

The manufacturer also under evaluated the amount of fibers exhausted from the product that contaminated the inside of the supposedly sealed device. These fibers were contaminating the anti-friction (bearing) and friction element (bronze bushing) to a stage where it was wearing the bushing and therefore caus-

Certified Bearing Specialist

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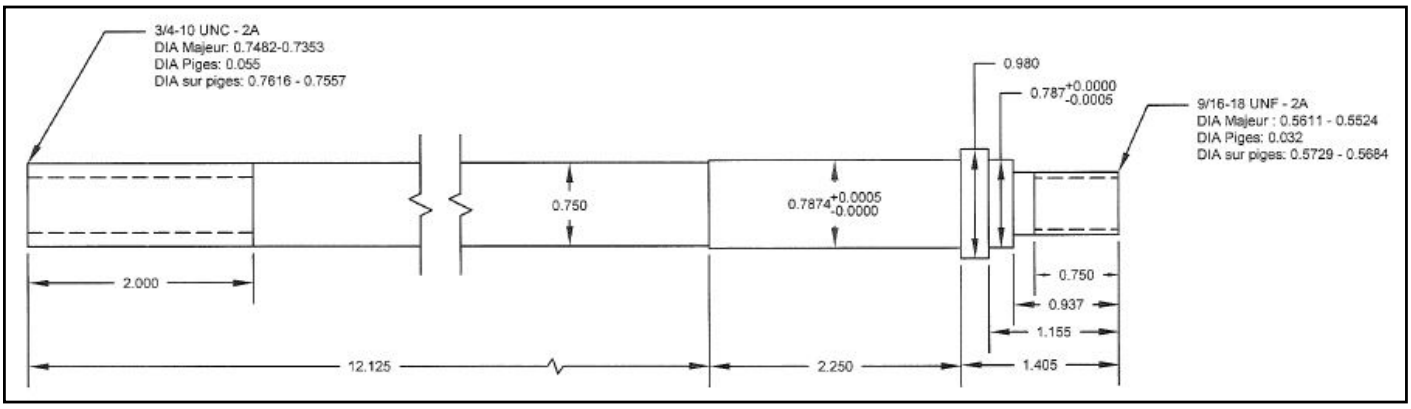


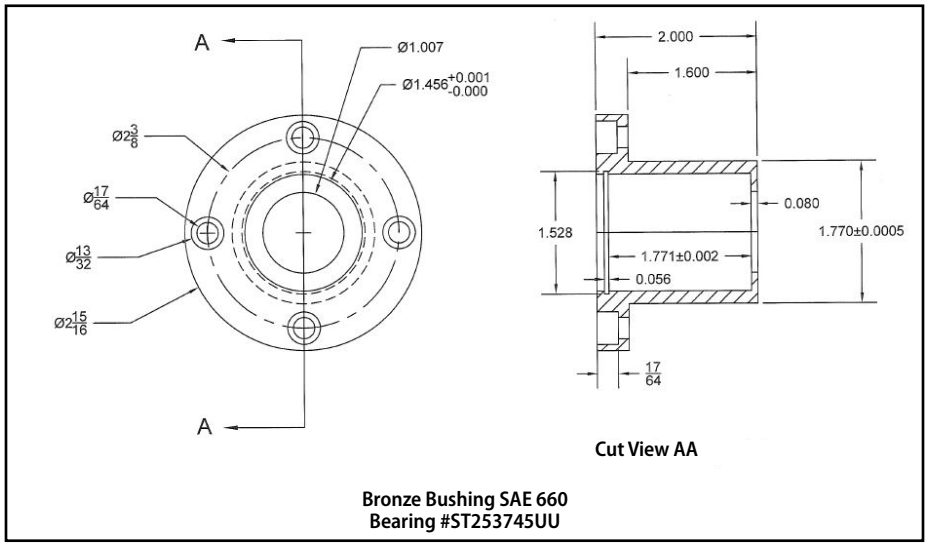
ing an excess of misalignment of the driving shaft.

We simply needed to control the misalignment by rectifying the linear motion and better seal the device. Linear motion is easily controllable with the use of a ball bushing bearing, like we all know, but standard all bushing bearings are not designed for rotary motions.

What was making this situation unique were the linear AND the rotary motions of the driving shaft. When coupled and driving, the 20-ft. long roll needed to be accepted at the same time by the same shaft action.

In order to do so, the OEM had installed a special bronze bushing at the other end of the driving shaft. It worked well, but only for a limited period of time. After a certain period, the bushing wears and misalignment occured again. The double thrust ball bearing with sphered housing washer cannot take the excess of misalignment (the bearing burn).


Fibers Contaminating The Equipment



Bronze Bushing SAE 660
Bearing #ST253745UU

This customer was used to changing the bearing and the bushing on a regular basis for so many years that it was kind of normal for him to do so.

BDI Canada Inc. decided to design a special modified shaft on which we have installed new bearings. This time, though, we decided to change the double thrust ball bearing and sphered washers to two tapered roller bearings in order to accept the radial load, which could not be taken by the ball thrust bearing.

We made drawings according to our specifications, tolerances and combined all specifications from what we learned at the BSA course. We then brought it to a professional machine shop to make this special shaft.

Now the real challenge was the stroking and rotary action of the shaft.

We could NOT get rid of the bronze bushing, as it was quite specially designed and part of the housing itself.

We modified this special bronze device to a steel one, drilled and tapped a lubrication hole for a grease fitting to be installed and fit a hardened bushing inside. We hardened the modified shaft so that we could use a linear/stroke/rotary ball bushing to travel on that hardened shaft that can also rotate on the hardened bushing in the new steel housing (which was making this application special). This new bushing was lubricated through the new lubrication fitting and was able to:

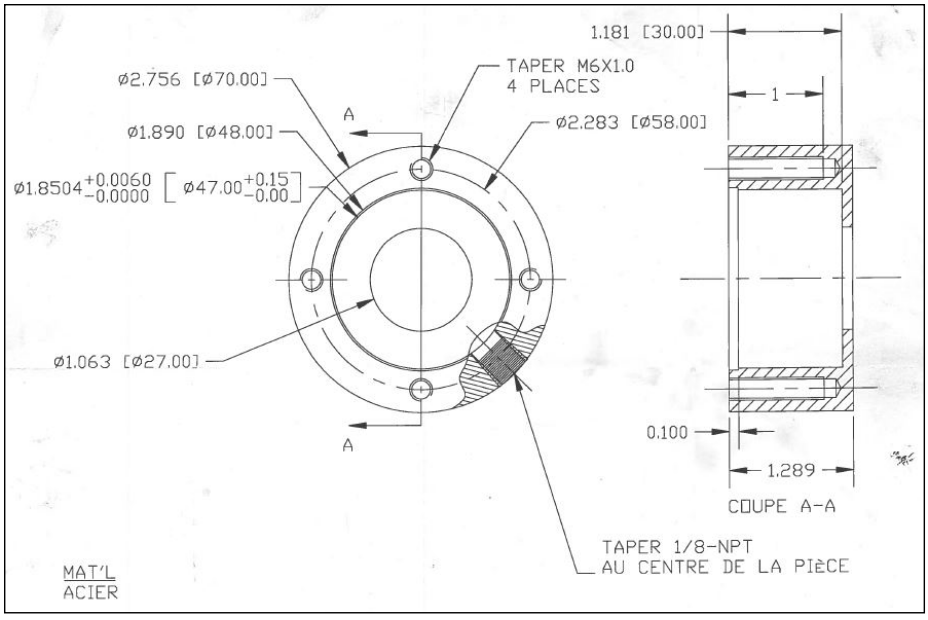
- Rotate with the shaft in harmony with the tapered roller bearings at the other end.
- Work in a linear motion on the hardened shaft as well as rotating on the bushing when the blade shaft was coupled and uncoupled.
- Keep the tissue fibers out as we selected a sealed linear/stroke/rotary ball bushing.

Our customer was quite shocked to see our capabilities of redesigning applications of an OEM with great success. He expressed his very high esteem towards those distributors such as BDI

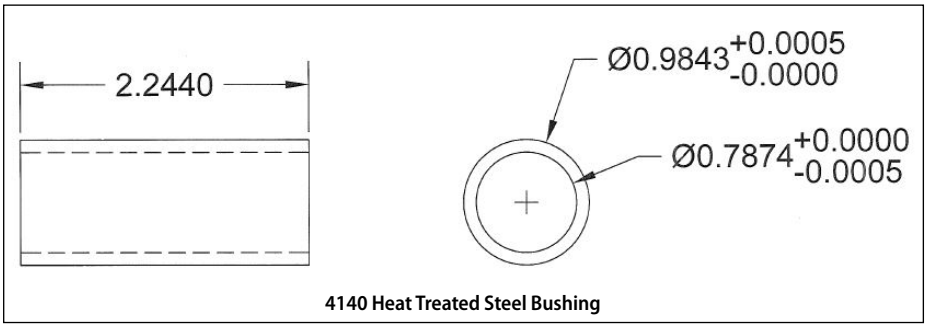
who understand the importance of training their representatives to an extent where they can improve mechanical performance of their equipment, lower downtimes and make their equipment more profitable."

Biography:

Eddy Swiben has been dedicated to BDI, Canada for the past 20 years and is a proud certified bearing specialist. Eddy is a true team player and proud to be a part of BDI Canada. His 20 years of experience, coworkers, company and CBS designation make him a valuable salesperson to both BDI Canada and its customers. **PTE**



BDI's customer is happy. Since then they have not changed any bearings, bushings or seals. The customer keeps the drawings, detailed specifications and identification nomenclature of the hardened steel bushings, tapered roller bearings and the rotary/stroke/linear ball bearings on file.



4140 Heat Treated Steel Bushing

Ceramic Bearings for Water Processing, Water Filtration and Liquid Handling Applications

Boca Bearing Company

Bearings are an essential component in the majority of mechanical designs and equipment. It is important to consider the most effective materials when designing industrial machinery, especially in applications where water or other liquids are present. Many materials will be unable to overcome the challenges associated with operating in a wet or corrosive environment.

To overcome the challenges faced by industries involved in water processing, water filtration and liquid handling, full ceramic bearings should be used. This article will outline the properties of full ceramic bearings, and enable the reader to determine whether they are the most appropriate type for their mechanical processes.

Comparing full ceramic materials' properties

There are a number of ceramic materials that can be used to produce full ceramic bearings. While these share a number of properties, they also offer distinct characteristics, which will help to determine the most suitable material for the machinery. Here's a guide to the most common materials used to produce full ceramic bearings:

Zirconium Oxide (ZrO_2)

Zirconium oxide was first used in the 1960s. It was used in space travel, creating a thermal barrier to enable space shuttles to enter the Earth's atmosphere. It copes well with high temperatures, but doesn't handle thermal shock resistance to the same extent as alternative ceramic materials such as silicon nitride. It's best used in high temperature environments that involve minimal loads. It's highly resistant to corrosion, which makes zirconia the perfect choice for use with highly corrosive liquids. It's an incredibly strong material, which also makes it ideal for use in mechanical applications involving fracture risk. ZrO_2 has an operating temperature range of –85°C to 400°C

Silicon Nitride (Si_3N_4)

Silicon nitride is a ceramic material produced using a series of chemical reactions, creating a full ceramic material with distinctive properties. The material is dark in color, and is one of the most superior types of ceramic material in terms of quality and durability. This material is relatively expensive, but the extra cost is worthwhile if you're looking for something that can withstand high temperatures and harsh mechanical conditions. In terms of withstanding high temperatures, silicon nitride is superior to alternative metallic solutions, and it has a lower thermal expansion coefficient than many alternative ceramic materials. This makes it an excellent choice when thermal shock resistance is a high priority. Si_3N_4 has an operating temperature range of –100°C to 900°C.

Aluminum Oxide (Al_2O_3)

Aluminum oxide is the most popular ceramic ball material, and its common uses expand far beyond the realms of ceramic bearings. It's produced through the process of calcination of aluminum hydroxide, which creates a durable and highly resistant ceramic material. This material is best known for its high compression strength, and its ability to resist corrosion when faced with a variety of abrasive chemicals, even when the environment involves extremely high temperatures. Less expensive than some of the alternative ceramic materials, aluminum oxide is readily available and is the most popular choice ceramic bearing for projects in which the available budgets are limited.

Silicon Carbide (SiC)

Silicon carbide is produced by chemically combining carbon and silicon atoms. It has excellent mechanic properties, which makes it a fantastic choice for use in the creation of bearings. Grains of silicon carbide have been used for many years as an abrasive,

most commonly in the form of sandpaper. However, these grains can be combined through sintering to create the highly durable ceramic material used to create silicon carbide bearings. This is a strong, durable ceramic material with a low density, low rate of thermal expansion, and fantastic thermal shock resistance, making it suitable for use in a wide variety of applications.

Ensuring extensive lifespan of bearings

Generally speaking, ceramic materials are extremely durable. Most of them are man-made using chemical processes, and consequently can withstand extremely high temperatures and corrosive materials.

Full ceramic bearings have a much longer lifespan than hybrid ceramic bearings or the steel alternatives, particularly when they aren't placed under a considerable load. This can be attributed to many properties of full ceramic bearings. Firstly, ceramics are much stronger. As a result, the balls or races of the bearing do not become distorted when placed under load. However, the superiority of full ceramic material increases with the load, and full ceramic materials are still at risk of premature failure in these cases.

The main limitation of ceramic bearings is the fact they can be quite brittle. Consequently, you must analyze the load to ensure the chosen material can cope with the stress. Zirconium oxide will handle large loads better than the rest of the full ceramic materials.

Electrical insulation with ceramic bearings

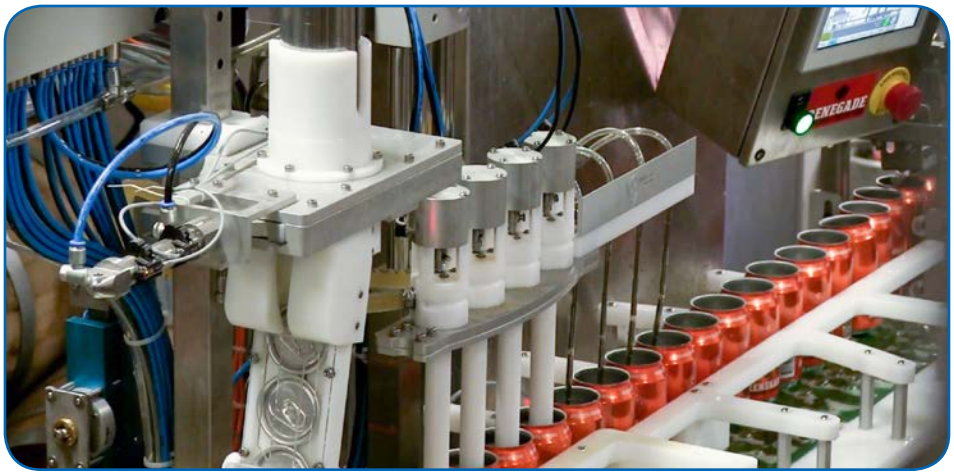
The ceramic bearings are also non-magnetic and, with the exception of silicon carbide, provide good electrical insulation. Silicon nitride offers the best electrical resistance, but is closely followed by zirconium oxide, which is readily available and fits within most budgets.

Improved performance of bearings in water and other liquids

Research has demonstrated that full ceramic bearings perform better than any alternatives when placed in water. Depending upon the material used, the lifespan can be up to 70 times longer than stainless steel bearings, a common alternative. The best ceramic materials for use in water processing environments are silicon nitride and zirconium oxide. Hybrid ceramic bearings also perform better than steel, but their lifespans are significantly shorter than full ceramic materials, which in some cases have a lifespan that's five times longer.

Resistance to corrosion

It is not feasible to use metallic bearings within industries handling water or other liquids, as they will corrode rapidly. When selecting the most appropriate material for the ceramic bearings, you should also consider the types of liquids the bearing will encounter. If the bearings will be used in environments containing corrosive materials, the lifespan will be significantly altered. Silicon nitride offers good resistance to the majority of



chemicals, so is often a good choice when the budget permits.

Temperature considerations

When deciding which material to use, it's important to consider the technical properties of each material to evaluate their suitability. One of the most important aspects to consider, particularly when working with liquids that may reach high temperatures, is the temperature of the environment in which you will be using the bearings. Silicon nitride can be used in environments reaching up to 1050°F, without loading. However, this can change significantly when used in industries handling liquids, as the bearings can encounter significant loading.

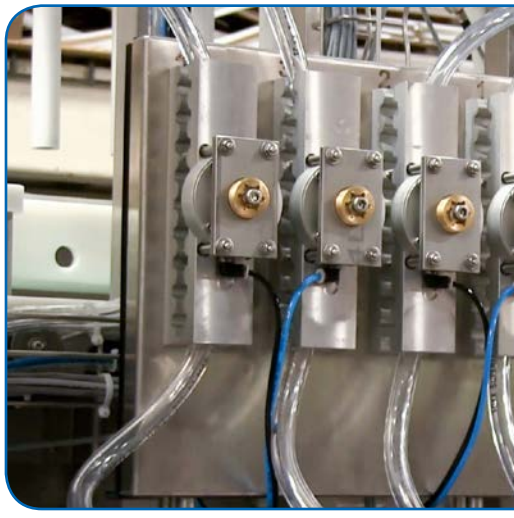
The coefficient of thermal expansion is possibly a more useful characteristic, as it provides an indication of the material's ability to cope in response to heating and cooling. Full ceramic bearings offer relatively low coefficients, compared to the non-ceramic alternatives. For example, silicon nitride has a coefficient of 3.2×10^{-6}/k and silicon carbide offers 3×10^{-6}/k. zirconium oxide and aluminum oxide are considerably higher, at 10.5×10^{-6}/k and 8.5×10^{-6}/k respectively, but both of these are much lower than bearing steel, which has a coefficient of 12.5×10^{-6}/k. In environments with considerable temperature changes, silicon nitride and silicon carbide are the best choices. They also offer good thermal shock resistance (up to 1112°F in silicon nitride, and 752°F in silicon carbide), which indicates minimal risk of fracture due to the changing temperatures.

Resistance to fracture under load

The material's ability to resist fracture is essential when used with liquids, such as water processing, as pressure is increased when submerged. Therefore, another characteristic that must be considered is fracture toughness. This indicates how capable the material is at resisting fractures in high-pressure environments. Zirconium oxide offers the best resistance, with a fracture toughness of 10 MPA*m1/2, closely followed by silicon nitride at 6.2 MPA*m1/2. These are consequently the best materials to use in a high-pressure environment, where the risk of cracks and fractures is high.

Wild Goose Engineering Success Story

Wild Goose Engineering is an engineering and machining company in Colorado. They partnered with a local brewery to develop an automated



canning line specially designed for the craft beer industry.

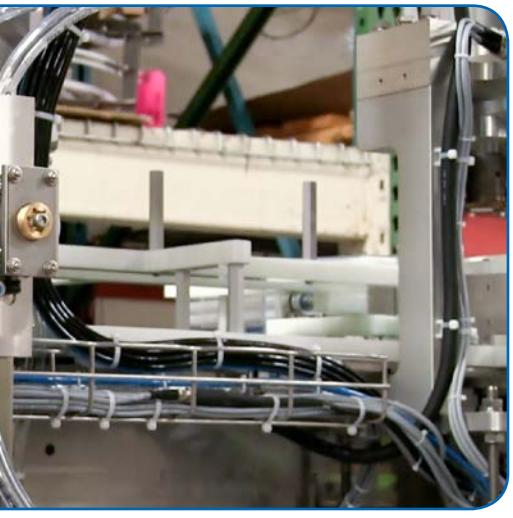
The canning system they created was not without its challenges. When you are dealing with any liquid, corrosion becomes a potential concern. Frequent washdowns and the beer itself can cause some mechanical components to corrode, gum up or fail completely. One such issue they found was that in their can lift and seamer, the constant spray of beer was causing the bearings to go bad very quickly. Downtime is a problem in any automation process.

Wild Goose Canning turned to Boca Bearing Company for help. They were able to identify the issues with their application and were able to offer the solution in the form of full ceramic bearings for the can lift and seamer. Ceramic bearings don't need lubrication, so there was no danger of chemical contamination, and they are FDA certified, and most importantly, ceramic won't corrode if it is exposed to water, cleaning chemicals, or the beer.

Boca Bearing Company and Wild Goose Canning are helping breweries to can their beers, and keep them operating safer, longer and more efficiently, so at the end of the day, they can kick back and enjoy a cold one.

Conclusion

The development of mechanical equipment for use in wet environments is no easy task, and selecting the right materials is vital to ensure the success of your business. Mistakes can be expensive, so it's important to understand the properties of the available resources. When it comes to bearings, metallic or hybrid options are simply not an option if significant contact with water is expected. Instead, full ceramic materials should be used to ensure the machinery will be built to last, and will operate efficiently for the duration of its use. **PTE**



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Linear Motors

Properties, Applications and Selection Guide

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*.

When the need arises for linear motion or positioning, there are many choices. One can use an Acme screw, ball screw, rack & pinion, or belts. The cost of a linear motor solution is generally greater than a mechanical linear product, but when one needs highly accurate, repeatable, high-speed motion, then the answer may be a linear motor.

Linear motors have found applications in just about all industries and markets where any of the following combination of attributes is required: long strokes, high speed, accuracy or repeatability. Mechanically driven linear products may have some of these attributes but only linear motors can have all of the attributes.

Linear motors are available in the same types as rotary motors. This is because a linear motor can be considered a rotary motor that has been slit open and rolled out flat. The major difference between linear motors and rotary motors is the part that moves. In a rotary motor, the motor windings are stationary while the motor core rotates. In a linear motor this is generally reversed: the motor windings or forcer moves while the core or rack base is stationary. This results in the base being very long compared to the forcer. For all linear motors to work, some kind of bearing support is required. This is usually provided by linear guides or bearings.

Some of the common linear motors are stepper, DC brush, synchronous, hybrid, induction, voice coil and force tube. All linear motors generate force rather than torque. Different characteristics of this force include the force speed characteristics, smoothness, stiffness and continuous and peak force ratings.

Voice Coil: The voice coil motor is the simplest type of linear motor. A permanent magnet is placed inside a coil of wire. As current is sent through the coil, the permanent magnet moves away from the coil. These motors can generate a lot of force but are limited in travel to an inch or so.

Force Tube: This type of linear motor places a stack of disk-shaped permanent magnets inside a hollow, non-magnetic tube. This tube is placed inside an assembly of coils. By selectively applying current to the coils, the tube moves through the coils or the coils move down the length of the tube. This type of linear motor can generate a lot of force but does not have the travel limits of voice coil motors.

Stepper: This linear motor works just like a rotary step motor and has all of the same advantages and disadvantages. They are most often operated open loop and move in discrete steps. Linear stepper motors are simple to commutate but have poor speed-force characteristics, are inefficient, and have low stiffness because they are operated open loop. Their main advantage is that the rack base of the motor is passive. The rack is basically a slab of iron with slots milled into it. Since the magnets and motor coils are located in the forcer, the rack base does not attract and capture ferrous materials.

Hybrid: The hybrid linear motor's construction is almost identical to the linear stepper motor. The motor's magnets and coils are just configured differently. The main difference is in its performance. It is operated closed loop so it hashigher stiffness and is more efficient.

Brush DC: The brush DC linear motor was one of the first linear motors. The rack base contains all of the motor winding while the forcer has the permanent magnets and the brushes. The motor is self-commutating, so in some applications no controller is needed. The rack base is complex, and the motor has all of the disadvantages of all brush type motors, including brush wear and arcing.

John Long, applications engineer, NSK Precision America, Inc. provided material for this article. Graphics provided by Baldor and the Schaeffler Group.

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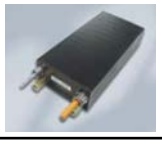
Induction: The induction linear motor is the only linear motor that does not use permanent magnets. The rack base consists of rods that are encapsulated such that all of the ends of the rods on each side are shorted together. The windings in the forcer induce currents in these rods to create a magnetic field. It is best suited for applications that have low duty cycle and long travels.

Synchronous: This is the most common type of linear motor. It is also known as a DC brushless linear motor or AC linear motor. They come in two styles - iron core and ironless core. The forcer of the iron core motor consists of a section of laminated iron with embedded motor windings. The rack base has permanent magnets affixed along its entire length.

The ironless core linear motor uses a U-shaped rack base that has permanent magnets affixed to both inside legs of the U-shaped channel. The forcer windings are embedded in a nonmagnetic core material that slides inside of the U-shaped channel. There is no iron used in the forcer. The iron core type linear motors dissipate heat better that the ironless core motors. To overcome the heat build-up in ironless core motors, they are available with cooling tubes built into the core through which air or a fluid is pumped to remove the heat.

There is one application for which linear motors are not generally suitable – vertical lifting. They can be used to lift objects but they need to be oversized to allow for a large continuous force to fight gravity or some type of counter balance needs to be designed into the system. Also some type of brake may be needed to hold the motor in position when power is lost. **PTE**

Quick Selection Guide	
Application	**Linear Motor Type**
Short Stroke, Light Load, High Frequency	Voice Coil
Short Stroke Moderate Load	Force Tube
Low Mass, Open Loop	Stepper
Long Travel and Low Duty Cycle	Induction
Low Cost and Low Duty Cycle	Brush DC
Smooth Motion	Ironless Core PM Synchronous
Machine Tool	Ironless Core PM Synchronous with liquid cooling.
General Automation	Iron Core PM Synchronous or Hybrid

Linear Motor Properties	
Motor Type	**Properties**
Voice Coil 	Speed: Very high Force: 35 lbf (160 N) Accuracy: Encoder dependent Cost: Low Limitations: Short travel.
Force Tube	Speed: 160 in/sec (4 meters/sec) Force: 1100 lbf (4800 N) Accuracy: Encoder dependent Cost: High Limitations: High profile.
Stepper 	Speed: 1 to 100 ips (25 to 2,500 min/sec.) Force: 2 to 50 lbf (9 to 220 N) Accuracy: 2 to 250 um. Cost: Low Limitations: Open loop, low stiffness, not efficient.
Hybrid 	Speed: 60 in/sec (1.5 meters/sec) Force: 180 lbf (800 N) Accuracy: Encoder dependent Cost: High Limitations: Speed force characteristics.
DC Brush 	Speed: 75 in/sec (3.8 meters/sec) Force: 171 lbf (1070 N) Accuracy: Encoder dependent. Cost: Moderate Limitations: Contamination from brush wear, brush wear, arcing of brushes.
AC Induction 	Speed: 270 in/sec (6.85 meters/sec) Force: 500 lbf (2,225 N) Accuracy: Encoder dependent. Cost: Moderate Limitations: Low Duty Cycle.
Iron Core AC Synchronous 	Speed: 400 ips (10 meters/sec) Force: 2,500 lbf (11,000N) Accuracy: Encoder dependent. Cost: High Limitations: Exposed magnets can attract and hold ferrous objects.
Ironless Core AC Synchronous 	Speed: 400 ips (10 meters/sec) Force: 450 lbf (2000 N) Accuracy: Encoder dependent. Cost: High Limitations: Exposed magnets can attract and hold ferrous objects. Needs liquid cooling for high force duty cycle.

WHEN A COMPANY CAN PRODUCE GEARS AND PUT THEM IN A GEARBOX, IT'S A PRETTY PICTURE.

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Guidelines for Bearing Seals

The Timken Company

Equipment downtime and reduced component life are a few of the consequences—and potential costs—of using the wrong seals on many types of industrial equipment including pump bearing frames, electric motors, fans, pillow blocks, gearboxes and more. However, if correctly specified and installed, seals provide effective barriers that both retain lubricants as well as protect against water, corrosion, debris and other contaminants.

Simply put, seals are used on rotating shafts to form a barrier with two basic functions: retain lubricants and exclude contaminants. In a typical application, an oil seal — also known as a rotary shaft, grease, fluid or dirt seal — is usually located adjacent to the bearing on most equipment. To retain the lubricant and prevent leakage, oil seals are designed to seal the spaces between stationary and moving mechanical components, such as the housing and shaft, which are found in nearly every type of machine and vehicle in operation.

Selecting the right seal elastomer compound

To ensure that seals will perform adequately and prevent abrasives, corrosive moisture and other harmful contaminates from entering sensitive equipment, the selection of the seal elastomer compound is critical. The application parameters and external environment in which a seal will operate need to be closely considered before choosing a compound. For general industrial environments, the most widely used elastomer is nitrile, due to its excellent abrasion resistance properties. The second most common elastomer is fluoroelastomer, preferred for its chemical and heat resistance capabilities.

Although two of the most important application parameters are temperature and lubricant type, it is also important to determine if any environmental contaminants will have an adverse chemical effect on the seal elastomer compound. Chemical compatibility tables are available from most seal suppliers but provide just a general guideline. For an in-depth analysis of elastomer compatibility, be sure to consult a seal engineer.

Other application parameters that must be taken into account are shaft run-out, shaft-to-bore misalignment, shaft speed and pressure. Bear in mind these parameters may vary greatly from one application to another. While operating a seal at the extreme end of just one parameter may have a small effect on its performance, operating it at multiple extremes in a system will have a much greater impact.

The temperature limitations and general fluid/lubricant compatibility for the most common and premium seal elastomer compounds are shown in Tables 1 and 2. It is important to note that since seal manufacturers each have their own proprietary elastomer formulations, the information in the tables (Page 43) may vary from one manufacturer to another.

Standard bearing seals often can't stand up to the toughest conditions. Talk to an expert about specific application requirements before selecting an elastomer compound.

Sealing system preparation

Once the proper seal elastomer compound is selected, it is essential to determine if the equipment components are properly specified in order to ensure good seal performance. More specifically, the seal is only one part of a sealing system, and its performance is dependent on the proper shaft and bore specifications to function correctly.

According to the Rubber Manufacturers Association (RMA), several shaft requirements should be considered at the original equipment design stage or during any upgrades. These considerations include shaft finish, grinding lead, hardness, diameter tolerances, chamfer, material, potential shaft-to-bore misalignment and dynamic run-out. Of these, the most important are the shaft finish, grinding lead and hardness.

Shaft finish is a major factor in the proper function of a seal and should be specified as 10–25 microinches Ra (0.20–0.60 micrometers Ra) with zero grinding lead. Regarding shaft materials, seals will function satisfactorily on mild steel, cast

Table 1 Most common materials and compounds for sealing elements.

Elastomer Compound	Advantages	Disadvantages/ Limitations	Temperature Range
Nitrile	Low cost. Good low temperature capability and abrasion resistance. Low swell in hydrocarbon fluids.	Does not have excellent heat resistance. Poor resistance to lubricants containing sulphur or EP additives, hydrocarbons/ oxygenate blends (gasoline/methanol). Poor ozone resistance.	–40° F to 225° F –40° C to 107° C
Polyacrylate	Resistance to EP lubricants. Higher heat capabilities than nitrile. Low swell in hydrocarbon fluids.	Limited to low temperature capability. Poor dry running capability. Subject to attack in aqueous media. Higher cost than nitrile.	–20° F to 300° F –29° C to 49° C
Silicone	Good dry heat resistance. Excellent low temperature capability. Good ozone resistance.	Easily damaged during installation. Poor chemical resistance to certain EP additives and oxidized oil. High swell, poor dry running performance. Higher cost than nitrile.	–80° F to 350° F –62° C to 176° C
Fluoro-elastomer	Excellent high temperature capabilities. Compatible with wide range of fluids. Very long life.	Poor resistance to basic (high pH>7) fluids. Attack by high-performance gear lubes. Expensive relative to other materials.	–30° F to 400° F –35° C to 204° C

Table 2 Premium materials and compounds for sealing elements.

Elastomer Compound	Advantages	Disadvantages/ Limitations	Temperature Range
Ethylene–Acrylic (Vamac®)	Higher heat capabilities than nitrile or polyacrylate. Better low temperature performance than polyacrylate. Good abrasion and dry running capability. Intermediate cost.	High swell in hydrocarbon fluids. Limited capabilities to follow eccentric shafts or perform in high–frequency applications.	–30° F to 325° F –34° C to 163° C
Tetrafluoro–Ethylene Propylene (Aflas®)	Better chemical resistance to all hydrocarbon fluids, acids, bases and oxidizing agents than fluoroelastomers. Capable of performing in the complete range of hydraulic fluids. Continuous heat resistance over 400° F. Fair dry abrasion and radiation resistance.	Poor chemical resistance to hydrocarbon/oxygenate blends (gasoline/methanol). Poor low temperature capabilities. More expense than fluoroelastomers.	–30° F to 400° F –34° C to 204° C

iron or malleable iron shafts. Under normal operating conditions, the section of the shaft being contacted by the seal lip should be hardened to Rockwell C30 minimum. In applications where the shaft may be nicked or damaged during handling or assembly, or for shafts that operate in harsh abrasive environments, a Rockwell C45 minimum is recommended.

Again, for a deeper analysis of the shaft chamfer, misalignment and other parameters, contact a seal engineer to discuss application details.

Meanwhile, in situations where the shaft does not meet the requirements for optimal seal operation, wear sleeves are typically available to provide the surface necessary for good seal performance. Not only does a wear sleeve provide the required surface, but it also offers a cost reduction to the alternative of refinishing the shaft to provide an adequate running surface for the seal lip.

Maintaining the proper bore specifications is also important to the integrity of the sealing system. To ensure proper fit of the selected seal, manufacturers' recommendations for bore tolerances and press fits should be followed closely.

Another characteristic to take into account is the bore configuration. The lead corner of the housing bore should be chamfered for ease of seal installation. It is important to take notice of rough corners or burrs that can scratch the seal outside diameter (O.D.) and cause potential leakage paths.

Basic seal design

The most widespread seal design in use today is shown in Figure 1 which is a typical rubber O.D. dual lip seal. A garter

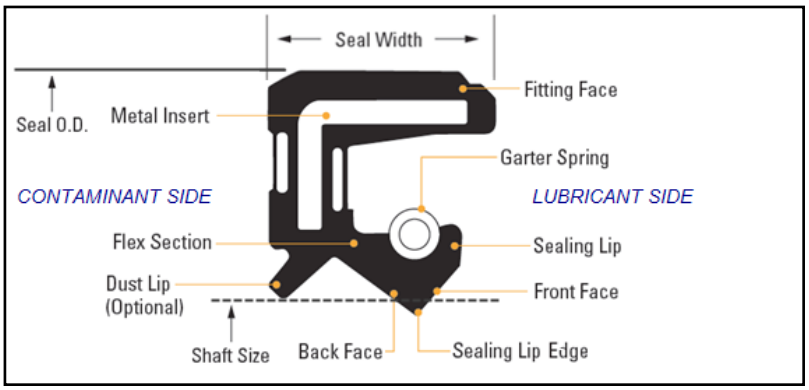

Figure 1 Rubber O.D. Dual Lip Seal Nomenclature.

spring is located behind that main seal lip which retains the lubricant. There is a secondary "dust lip" next to it that faces the opposite direction to exclude contaminants.

The four most popular seal designs are shown in Figure 2. The main difference is the O.D. of the seal. The metal O.D. seals will provide slightly better retention in the housing bore than would the rubber O.D. seals. However, their carbon steel cases may rust depending upon the environment, while the rubber O.D. seals will not. For many standard applications the seals may be considered interchangeable. Dual-lip seal designs have the optional "dust lip" and should definitely be used in contaminated environments. All of these types of seals are available in both metric and inch sizes.

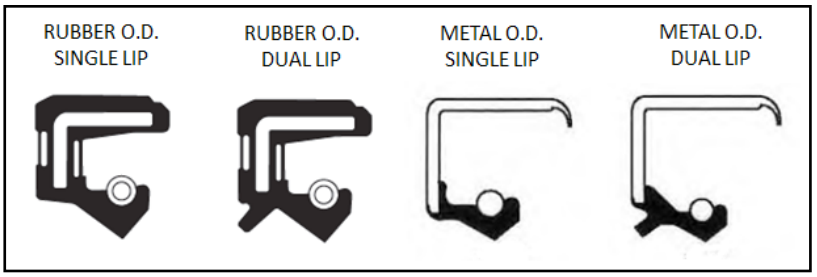

Figure 2 Most Widely Used Seal Designs.

Proper installation for maximum performance

Even if the proper seal elastomer compound, seal type and equipment design are selected and verified, the reliability of the sealing assembly still relies heavily on successful installation. Proper installation guidelines include:

1. Inspect the housing bore to make sure it is clean and free of burrs that might distort the seal or scratch the O.D., leading to possible leaks. Check for roundness and make sure the leading edge is either rounded or chamfered.
2. Inspect the shaft for machining burrs, dirt or paint that might damage the seal lip area, resulting in a leak path. If the previous seal being replaced has worn a groove into the shaft, then that area must either be refinished or covered with a shaft sleeve.
3. Inspect the end of the shaft and remove all burrs or sharp edges. The end should also be chamfered or have a radius to assure the seal lip is not damaged during installation. If not possible, consider protecting the seal lip with a tapered sleeve.
4. Inspect splines and keyways for sharp edges; if present they should be covered with a sleeve, shim stock or tape to protect the seal lip.
5. Inspect the seal itself for damage that may have been caused during shipping and handling, such as nicks, cuts, scratches or distortion.
6. Assure proper seal direction. The main seal lip usually faces the lubricant to be sealed in. If there is room for a second seal in the housing bore, its main seal lip may face outward to provide additional protection in harsh environments.
7. Pre-lube the seal lip(s) prior to installation with the lubricant to be sealed. It is not necessary to lube the O.D. of metal seals, but a very light film of oil should be applied to the O.D. of rubber-coated seals to aid in the installation process and reduce stress during installation. This pre-lube should reduce or eliminate the possibility of a rubber O.D. seal backing out of the bore immediately after installation.
8. Select an installation tool appropriate for the application. The best tool will have a diameter slightly smaller than that of the housing bore and will apply force only on the seal case. Bearing races may be used as an installation tool adapter when "approved tools" are not available.
9. Never hammer directly on the seal. Screwdrivers, drift pins or punches should not be used as installation tools. Steel hammers also are not recommended for use with approved installation tools; the shock of the hammer can potentially dislodge the garter spring. After the seal has started to enter the bore, the seal should be driven or pushed in evenly with only enough force to seat it.

Additional options for harsh environments

For the most challenging conditions, oil seals are available in a variety of styles, including multi-lip designs. A standard double-lip design, made of nitrile or fluoroelastomer, can be used as a primary sealing element. However, in extremely harsh environments, an optional V-seal should be added outside the oil seal on the shaft to act as a contaminant excluder or back-up seal for additional protection as shown in Figure 3.

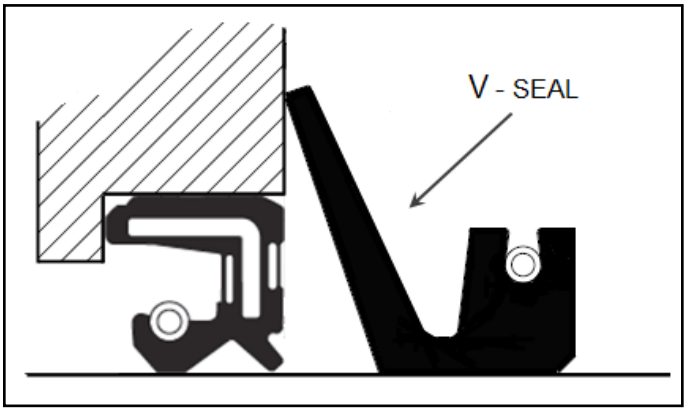

Figure 3 V-seal.

Another benefit of the V-seal is its elasticity, which enables ease of installation on a broader range of shaft sizes. V-seals can also be used on eccentric or misaligned shafts. **PTE**

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Determining Diametral Pitch, Center Distance

THE QUESTION

I need help determining the diametral pitch needed to achieve the closest center-to-center distance for 2 spur gears. The 1st gear is a 34-tooth and the 2nd gear is a 28-tooth. The center-to-center distance between the gears needs to be as close to 2⅛" as possible.

Expert response provided by Hermann J. Stadtfeld, Gleason Corp. The center distance between two cylindrical gears is calculated by adding the two pitch diameters and dividing the result by two. If the number of teeth is given, the pitch diameter can be calculated by dividing the number of teeth by the diametral pitch. If we plug those relationships into each other and solve the equation for the diametral pitch, then this results in: $DP = (z_1 + z_2) / (2 \cdot a)$, as shown in Figure 1.

In many cases, a profile shift is applied to one or both gear members. The profile shift factors will change the center distance, except in situations in which the pinion and gears use the same profile shift factor, but with opposite signs (V0 System). The most common reason for profile shift is the avoidance of undercut. Given the fine pitch geometry and the tooth numbers of the present gearset, a profile shift factor is most likely not required.

The resulting diametral pitch is valid in the face plane of the pinion and gear. With spur gears, this is also consistent with the normal diametral pitch and therefore can be used in selecting a suited hobbing tool.

In the present case the number of teeth and the given center distance deliver a diametral pitch of 14.588 1/inch. The series of standard hobs shows the availability of 14 DP and 16 DP. If 14 DP is chosen, then a center distance of 2.214 inch is required. If this dimension is too large, then the alternative is to manufacture the two gears with the 16 DP hob, which will result in a center distance of 1.936 inch.

If both results are too far away from the desired center distance, then a metric hob with a module of 1.75 mm could be an acceptable alternative. The m = 1.75 mm hob will deliver a center distance of 54.25 mm, equal to 2.1358 inch, which is $^{11}/_{1000}$ inch larger than the ideal target dimension.

Dr. Hermann J. Stadtfeld is vice president bevel gear technology — R&D at Gleason Corp.

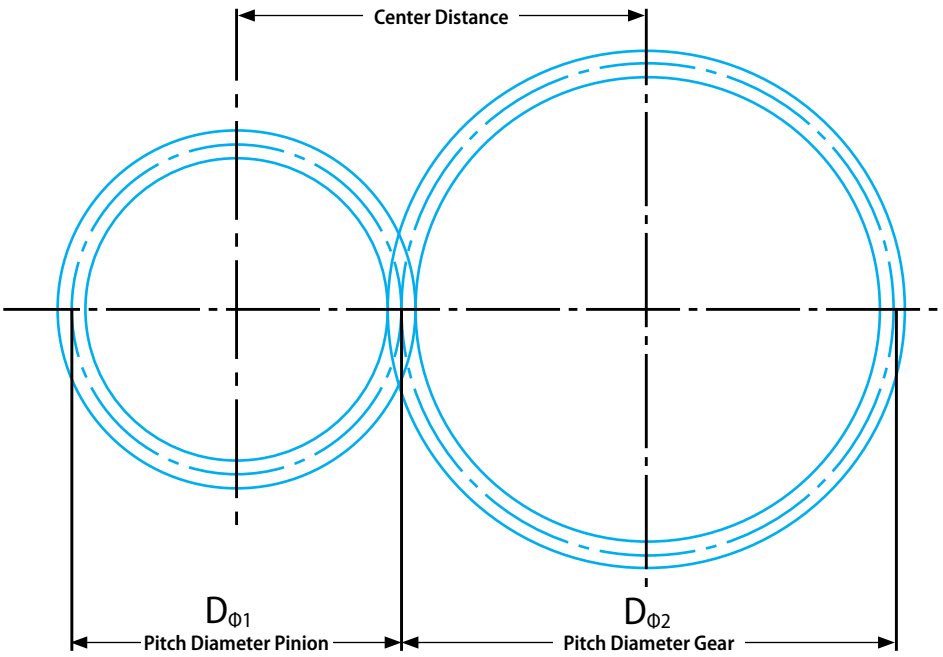

Figure 1 Relationship between number of teeth, DP and center distance.

$$D_{\Phi 1} = \frac{Z_1}{DP} \qquad D_{\Phi 2} = \frac{Z_2}{DP}$$

$$a = \frac{D_{\Phi 1} + D_{\Phi 2}}{2} = \frac{Z_1 + Z_2}{2\,DP}$$

$$DP = \frac{Z_1 + Z_2}{2 \cdot a} \quad \text{or} \quad m_f = \frac{2 \cdot a}{Z_1 + Z_2}$$

where

a = Center Distance
DP = Diametral Pitch
$D_{\Phi 1}$ = Pitch Diameter Pinion
$D_{\Phi 2}$ = Pitch Diameter Gear
m_f = Face Module
Z_1 = Number of Teeth (Pinion)
Z_2 = Number of Teeth (Gear)

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ISO 281:2007 — Caveat Emptor!

Erwin V. Zaretsky, PE

Introduction

In the July 2010 issue of the Society of Tribologists and Lubrication Engineers, *Tribology and Lubrication Engineering*, *TLT*, there is an article (Ref. 1) written by its staff entitled, "ISO 281:2007 Bearing-Life Standard — And the Answer Is?" The lead caption to the article is, "Every major industrial nation in the world accepts the new bearing-life standard (ISO 281:2007) (Ref. 2) except the U. S.

Why? And what does it mean for the industry?"

For this article the *TLT* staff interviewed three persons who were involved with the development of the standard. These were Myron McKenzie, chief engineer, American Roller, Morgan, NC; Dan Snyder, industry consultant, who had retired as director of application engineering for SKF Industries, Lansdale, PA and Martin Correns, director, advanced engineering analysis and simulation, INA – Schaeffler KG, Herzogenaurach, Germany. The *TLT* article (Ref. 1) is well written and, I believe, accurately reflects the opinions of the three interviewees who were in favor of adoption of ISO 281:2007 Bearing-Life Standard by the United States through ANSI/ABMA. In the article, I was cited as a major opponent of this standard, which is correct. For those interested in this subject, the article provides a reasonably good history and technical background and can be obtained online.

Myron McKenzie, Dan Snyder and I have been serving as voting members to two ANSI/ABMA Standards Committees. One committee — ANSI/ABMA B-3 — votes directly to adopt and/or modify bearing standards in the United States. The other committee — U. S. TAG (Technical Advisory Group) — advises the United States representative to ISO how they should vote on various issues, including adopting and modifying ISO Standards. Both U. S. ANSI/ABMA committees compromise members from bearing producers, users and generally interested parties — such as me.

ISO 281:2007 is one of the issues on which we disagree; this ISO 281:2007 standard was not recommended nor adopted by a majority in either committee.

The American Standards Institute (ANSI)/American Bearing Manufacturers Association (ABMA) standards 9 and 11 (Refs. 3–4) are used for the load ratings and life prediction of ball and roller bearings, respectively. These standards, with various updates through the years, were adopted by the ABMA in 1953. (ABMA changed their name from the Anti-Friction Bearing Manufactures Association [AFBMA] in 1993.)

Background

ANSI/ABMA Standards 9 and 11 (Refs. 3–4) are based on the Lundberg-Palmgren life model published in 1947 (Ref. 5) and partially revised in 1952 (Ref. 6). However, the life model of Gustaf Lundberg and Arvid Palmgren dates back to 1924. At that time, Palmgren (Ref. 7), who had been working at SKF in Sweden since 1917, published a paper in German outlining his approach to bearing life prediction (Ref. 7). He presented an empirical formula based on the concept of an L_{10} life, or the time that 90 percent of a bearing population would equal or exceed without rolling-element fatigue failure. This 1924 paper by Palmgren (Ref. 7) is the first time in the literature that a probabilistic approach to life prediction of a machine element was formulated (Ref. 8).

Even where a ball or roller bearing was properly designed, manufactured, installed, lubricated and maintained, rolling-element fatigue will limit the useable life of the bearing. In the life equations that Palmgren (Ref. 7) presented, he incorporated a "fatigue limit," or load below which no failure will occur, as well as a time or "location parameter" before which time no failure should occur.

Over the next 12 years Palmgren evolved his bearing life prediction formulae, eventually recanting his earlier idea of a fatigue limit. In 1936 Palmgren (Ref. 9) published the following:

"For a few decades, after the manufacture of ball bearings had taken up on modern lines, it was generally considered that ball bearings, like other machine units, were subject to a fatigue limit, i.e. that there was a limit to their carrying capacity beyond which fatigue speedily set in, but below which the bearings could continue to function for infinity. Systematic examination of the results of tests made in the SKF laboratories before 1918, however, showed that no fatigue limit existed within the range covered by the comparatively heavy loads employed for test purposes. It was found that so far as the scope of the investigation was concerned, the employment of a lighter load invariably had the effect of increasing the number of revolutions a bearing could execute before fatigue set in. It was certainly still assumed that a fatigue limit coexisted with a certain low specific load, but tests with light loads finally showed that the fatigue limit for infinite life, if such exists, is reached under a load lighter than all of those employed, and that in practice the life is accordingly always a function of load."

In other words, Palmgren (Ref. 9) in 1936 concluded that for bearing steels, and more specifically, for AISI 52100 steel, no fatigue limit existed as a practical matter.

What's the Issue?

I was invited by Tom Astrene of *TLT* to write a response to the July 2010 *TLT* article (Ref. 1). My rebuttal — "In Search of a Fatigue Limit: A Critique of ISO Standard 281:2007" — was published in *Tribology and Lubrication Engineering*, *TLT*, August 2010 edition (Ref. 10). While this article is also available online, I will attempt to summarize the essence of my response.

In 1982 H. K. Lorosch (Ref. 11), of FAG Bearing Company (now part of INA-Schaeffler KG), published results of fatigue tests on three groups of vacuum-degassed, 7205B-size AISI

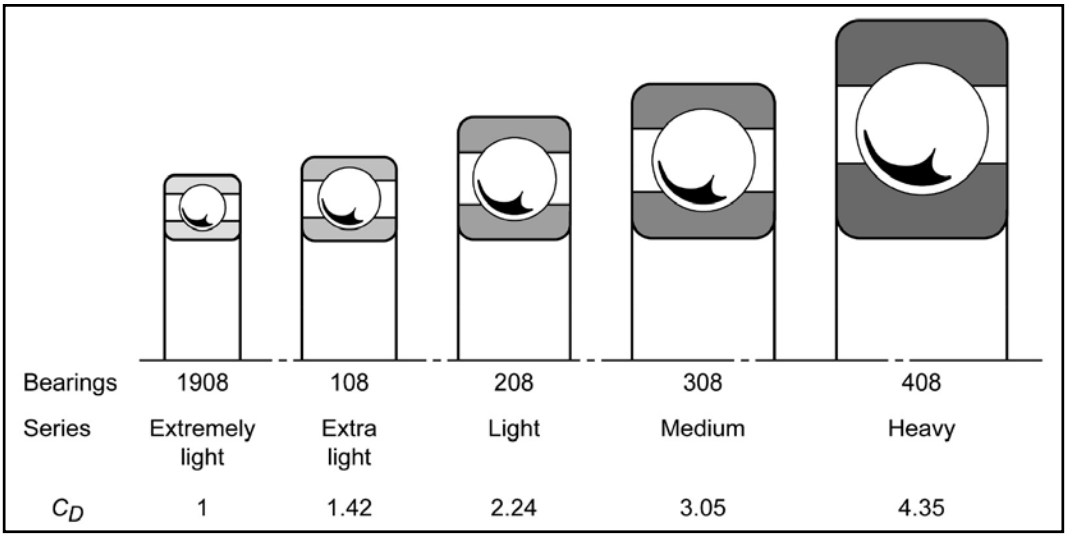

Figure 1 Effect of bearing series on relative sizes and dynamic capacities, C_D, of 40-mm deep-groove ball bearings (Ref. 20).

52100 inner races at maximum Hertz stresses of 2.6, 2.8, and 3.5 GPa (370, 406, and 500 ksi), respectively. These were very highly loaded bearings. From these tests Lorosch concluded that, "Under low loads and with elastohydrodynamic lubrication, there is no material fatigue, thus indicating that under such conditions bearing life is practically unlimited."

O. Zwirlein and H. Schlicht (Ref. 12), also of FAG Bearing Company, in a companion paper published concurrently in 1982 with that of Lorosch, and using the same 7205B-size bearing inner races, reported large amounts of compressive residual stress due to the transformation of retained austenite into martinsite. Bearing research performed at the General Motors Research Center in Warren, Michigan in the 1950s and early 1960s showed that these compressive residual stresses can significantly increase bearing life (Refs. 13-16).

Lorosch, Zwirlein and Schlicht (Refs. 11-12) failed to account for the presence of these significant, induced compressive residual stresses in their bearing raceways. Instead they assumed that the large increases in life that they reported were due to a "fatigue limit." Zwirlein and Schlicht (Refs. 12) concluded that, "Contact pressures (maximum Hertz stresses) less than 2.6 GPa (370 ksi) do not lead to the formation of pitting within a foreseeable period. This corresponds to 'true endurance.'" However, their observation is not supported by rolling-element fatigue data in the open literature for maximum Hertz (contact) stress levels below 2.6 GPa (370 ksi). If Lorosch, Zwirlein and Schlicht (Refs. 11-12) were correct, no bearing in rotating machinery applications would fail due to classical rolling-element fatigue.

Based on the FAG criteria, for a ball bearing the fatigue limit occurs at a maximum Hertz stress of 2.0 GPa (292 ksi). For roller bearings the fatigue limit occurs at a maximum Hertz stress of 1.4 GPa (205 ksi). It is difficult for me to reconcile that for the same bearing steel there are two separate fatigue limits — one for ball bearings and the other for roller bearings — that are so significantly different (Ref. 10).

In 1985, based on the results reported by Lorosch, Zwirlein and Schlicht (Refs. 11-12), Stathis Ioannides and Tedric A. Harris (Ref. 17) at the SKF Engineering and Research Centre in Nieuwegein, The Netherlands, applied Palmgren's 1924 concept (Ref. 7) of a "fatigue limit" to the 1947 Lundberg-Palmgren equations. However, in their 1985 paper (Ref. 17) Ioannides and Harris either did not know or, if they knew, did not reference that Palmgren, also from SKF, discarded the concept of a fatigue limit in 1936 (Ref. 7).

Subsequently, according to Myron McKenzie (Ref. 1), the ISO (in Europe) began to shift its focus on the use of the Ioannides and Harris fatigue life model incorporating a fatigue limit into their bearing life predictions. According to Martin Correns (Ref. 1), a German (Institute for Standardization) DIN standard was published in Germany in 2003 that incorporated a fatigue limit that became part of ISO 281:2007 standard (Ref. 2) four years later. The fatigue limiting maximum Hertz (contact) stress corresponds to 1.5 GPa (218 ksi). This essentially means that were you to run a ball or roller bearing at or below this stress, rolling-element fatigue life would be infinite, or the bearing should not be expected to fail from rolling-element (contact) fatigue. Furthermore, at higher contact stresses, fatigue life would be significantly increased by a reduction in the magnitude of the critical sub-surface shearing stress that causes fatigue.

In 2012, two companion papers (Refs. 18-19) were published in the *International Journal of Fatigue* by researchers from the SKF Engineering and Research Center rationalizing the presence of a fatigue limit in through hardened bearing steels, and the use of a fatigue limit in the ISO 281:2007 standard (Ref. 2). You, the reader, can make up his or her mind regarding the technical contents of these papers and whether, based upon the preponderance of their data, that content supports and justifies the application of a fatigue limit in the standard.

What is the Advantage or Disadvantage of the Fatigue Life Limit?

In order to answer this question, the following hypothetical example is presented. Assume that a gearbox manufacturer designs and manufactures a 2-to-1 ratio speed reducer comprising a high-speed input shaft supported by two medium series, deep-groove ball bearings, and a low-speed output shaft also supported by 2 medium deep-groove ball bearings

of the same size as those on the input shaft. (Relative bearing sizes and their respective dynamic load capacities, C_D, are illustrated in Figure 1 (Ref. 20). Further assume that, using the ANSI/ABMA life calculation method from the standards (Refs. 3–4), the calculated L_{10} lives of each of the bearings on the input shaft are 100,000 hours each and the calculated L_{10} lives for each of the bearings on the output shaft are 50,000 hours. Using "strict series reliability" (Ref. 21), the L_{10} bearing system life will be 18,800 hours. The system life is always less than the lowest lived component in the system. It is assumed for this example that the gears will not fail.

Subsequently, the gearbox manufacturer recalculates his bearing life using the ISO 281:2007 standard (Ref. 2) that contains a fatigue limit. During the course of his calculations he discovers that he can substitute, in this case, a light series (smaller) bearing having a smaller outside diameter at lower cost and, theoretically, retaining the same life and reliability as the larger, medium series bearing based on the ANSI/ABMA calculations. With the assumption of a fatigue limit the calculated bearing lives and system life remain the same. The gearbox manufacturing costs are reduced and the weight and size of the gearbox structure can be marginally reduced. The gearbox manufacturer goes with the ISO 281:2007 standard, the fatigue limit, and the small series bearing.

As a marketing inducement, if a gearbox (bearing) failure occurs, the manufacturer warrants the gearbox with a new replacement for one year or 2,000 hours of operation — whichever comes first after purchase and delivery. Life calculations using the ISO 281:2007 standard, together with Weibull statistical analysis, predict that for every 1,000 gearboxes manufactured, 9 gearboxes will be returned as a result of a failed bearing the first year. This means that 9 bearings out of the 4,000 bearings in service, or less than a quarter of one percent, will fail during this time period. However, "If a fatigue limit does not exist" for the bearings in service, the predicted bearing system L_{10} life is reduced from 18,800 hours to 7,520 hours. As a result the gearbox warranty claims would be expected to increase from 9 gearboxes to 24 gearboxes in their first year of service. This also means that 24 out of the 4,000 bearings in service, or 0.6 percent of the bearings, would have failed from fatigue.

For purposes of this hypothetical example, assume further that a large utility purchases 1,000 of these gearboxes to attach to cooling system pumps. The gearbox usage is projected for each pump at approximately 2,000 hours-per-year. The utility wants to project the number of gearbox repairs and/or replacements they can expect over a 5 year period. Based upon the gearbox manufacturer's ISO 281:2007 standard calculations and an 18,800 hour bearing system L_{10} life, approximately 50 gearboxes are projected to be repaired and/or replaced over the 5 year period. However, assume that the bearing calculation does not incorporate a fatigue limit. The resultant bearing L_{10} life system is 7,520 hours. For 10,000 hours of operation (5 years), 130 gearboxes would project to being repaired and/or replaced.

Rolling-element bearing failure time (life) is not deterministic, but probabilistic. The rolling-element bearing life standards are meant to allow the engineer to predict the probability of fatigue failures occurring. Hence, the calculated L_{10} life is the time beyond which 90% of a bearing population will be expected to survive, and before which time 10% will be expected to fail from fatigue. You cannot determine the life of a single individual bearing out of a population — only its probability of survival under its designated operating conditions. But in this writer's opinion, the bearing standards also allow the engineer to assess risk, plan for maintenance and replacement, and perhaps reduce costs. While the above example is hypothetical, it is meant to illustrate that the specific standard used can have significant economic impact. The question that the customer needs to ask the product manufacturer is, "How did you make your life and reliability calculations?" Regarding the above example, in this writer's opinion, a reasonably prudent engineer should use the 130 gearbox replacement projection for planning purposes. In the end — as always — Caveat Emptor! "Let the buyer beware!" **PTE**

(*Editors' Note: Do you have an opinion or question regarding the above? The author would love to hear from you. Please send your questions/comments to: jmcguinn@powertransmission.com.*)

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Erv Zaretsky is an engineering consultant to industry and government, noted author and lecturer, adjunct professor of engineering at Case Western Reserve University and distinguished research associate at the NASA Glenn Research Center in Cleveland, where he recently retired. He has more than 50 years of experience in mechanical engineering related to tribology, rotating machinery, fatigue and probabilistic life prediction. He has written over 200 technical papers and two books and has lectured widely throughout North America, Europe, Asia and the Middle East. He is a Fellow of both ASME and STLE and a member of two ANSI/ABMA Committees on Rolling Bearing Standards. In 1998 he was appointed to the Senior Scientific and Professional Corp., the highest rank achievable by a federal engineer or scientist. He has received four I-R 100 Awards established by the editors of *R&D Magazine*. In 1999 STLE presented Zaretsky with the Wilbur Deutsch Memorial Award, which honors the most outstanding paper written on the practical aspects of lubrication. He is also the recipient of numerous NASA awards for his contributions to the Space Program, among which are the NASA Medal for Exceptional Engineering Achievement, NESC Director's Award and the Astronauts' Silver Snoopy Award. You can reach him at *evzaretsky@gmail.com*.

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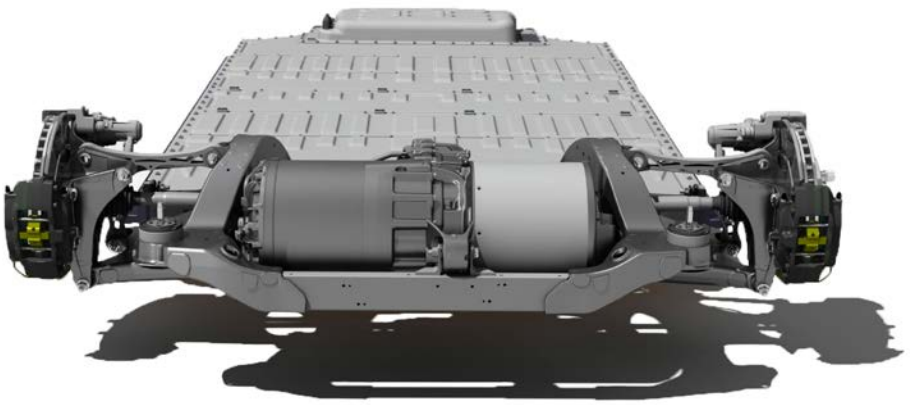
How Does An Electric Motor Work?

Jill Scott



"*Everybody recognizes that if you can make very efficient electric motors, you can make a quantum leap forward.*"
— James Dyson

Introduction

"The electric motor has become a little more well-known and appreciated over the past few years, with its improving integration into automobiles. With most people understanding and appreciating the impact that gasoline pollution has on the climate, there has been a greater demand for auto manufacturers to create cars that can help to improve our environment — or at the very least — do less harm.

"It is through this demand for growth and development that some of the world's greatest inventors have refined the electric motor to now work better and be more efficient than it ever was before."

Parts of an Electric Motor

A three-phase, four-pole induction motor is made of two main parts — a stator and a rotor.

Stator. The stator (Figure 1) is made of three parts — a stator core, conducting wire, and frame. The stator core is a group of steel rings that are insulated from one another and then laminated together. These rings include slots on their inside that the conducting wire will wrap around to form the stator coils.

Simply put, in a three-phase induction motor, there are three different wire types. You can call these wire types Phase 1, Phase 2, and Phase 3. Each wire type is wrapped around the slots on opposite sides of the inside of the stator core.

Once the conducting wire is in place within the stator core, the core is placed within the frame.

How Does an Electric Motor Work?

If you're an electrical engineer you know how an electric motor works; if you aren't, it can be extremely confusing. Therefore, here's the simplified explanation (or the "how an electric motor works for dummies" version) of how a four-pole, three-phase AC induction motor works in a car.

Figure 1 The stator is made of three parts — a stator core, conducting wire, and frame.

It starts with the battery in the car that is connected to the motor. Electrical energy is supplied to the stator via the car's battery. The coils within the stator (made from the conducting wire) are arranged on opposite sides of the stator core and act as magnets, in a way. Therefore, when the electrical energy from the car battery is supplied to the motor, the coils create rotating, magnetic fields that pull the conducting rods on the outside of the rotor along behind it. The spinning rotor is what creates the mechanical energy needed to turn the gears of the car which, in turn, rotate the tires.

Now in a typical car, i.e., non-electric, there is both an engine and an alternator. The battery powers the engine, which powers the gears and wheels. The rotation of the wheels is what then powers the alternator in the car and the alternator recharges the battery. This is why you are told to drive your car around for a period of time after being jumped — the battery needs to be recharged in order to function appropriately.

There is no alternator in an electric car. So, how does the battery recharge then? While there is no separate alternator, the motor in an electric car acts as both motor *and* alternator. That's one of the reasons why electric cars are so unique. As referenced above, the battery starts the motor, which supplies energy to the gears, which rotates the tires. This process happens when your foot is on the accelerator — the rotor gets pulled along by the rotating magnetic field, requiring more torque. But what happens when you let off of the accelerator?

When your foot comes off the accelerator the rotating magnetic field stops and the rotor starts spinning faster (as opposed to being pulled along by the magnetic field). When the rotor spins faster than the rotating magnetic field in the stator, this action recharges the battery, acting as an alternator.

To simplify this process, imagine pedaling a bike up a hill. To get to the top of the hill you need to pedal harder and might even have to stand up and expend more energy to rotate the tires and reach the peak of the hill. This is similar to pressing down on the gas. The rotating magnetic field pulling the rotor behind it creates the resistance (or torque) needed to move the tires and car. Once at the peak of the hill, you can take it

Article reprinted courtesy of SaveOn Energy.

easy and recharge while the wheels move even faster to take you down the hill. In the car, this happens when you let your foot off the gas and the rotor moves faster and feeds electrical energy back into the power line to recharge the battery.

What is alternating current (AC) vs. direct current (DC)? The conceptual differences behind these two types of currents should be fairly obvious; while one current (DC) is consistent the other (AC) is more intermittent. However, things are a bit more complicated than just that simple explanation, so let's break these two terms out in a bit more detail.

Direct current (DC). The term direct current refers to electricity that moves in a singular and consistent direction at all times. Furthermore, a direct current's voltage maintains a regular polarity; that is, one that does not change.

Think of how batteries have clearly defined positive and negative sides to them. They use direct currents to send the same voltage out on a consistent basis. In addition to batteries, fuel cells and solar cells also produce direct currents, while simple acts like rubbing certain materials together can produce DC as well.

In keeping with our battery concept, when considering the positive and negative sides of the battery, it is important to note that the direct current always flows in the same direction between the positive and negative side. This ensures that both sides of the battery are always positive and negative.

Alternating current (AC). The term alternating current defines a type of electricity characterized by voltage (think water pressure in a hose) and current (think rate of water flow through the hose) that vary with respect to time (Fig. 2). As the voltage and current of an AC signal change, they most often follow the pattern of a sine wave. Due to the waveform being a sine wave, the voltage and current alternate between a positive and negative polarity when viewed over time. The sine wave shape of AC signals is due to the way in which the electricity is generated.

Another term you may hear when discussing AC electricity is frequency. The frequency of the signal is the number of complete wave cycles completed during one second of time. Frequency is measured in Hertz (Hz) and in the United States the standard power-line frequency is 60 Hz. This means that the AC signal oscillates at a rate of 60 complete back-forth cycles every second.

So Why is this Important?

AC electricity is the best way to transfer useable energy from a generation source (i.e., a dam or windmill) over great distances. This is due to the alternating nature of the AC signal that allows the voltage to be easily stepped up or stepped down to different values. This is why your home's outlets will say 120 volts AC (safer for human consumption) but the voltage of a distribution transformer which supply power to a neighborhood (those cylindrical grey boxes you see on the power line poles), might have voltage as high as 66 kVA (66,000 volts AC).

AC power allows us to construct generators, motors, and distribution systems from electricity that are far more efficient than direct current, which is why AC is the most popular energy current for powering applications.

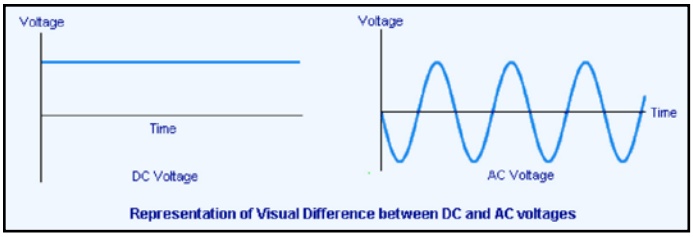


Figure 2 The term alternating current defines a type of electricity characterized by voltage and current that varies with respect to time.

How Does A Three-Phase, Four-Pole Induction Motor Work?

Most large, industrial motors are induction motors and they are used to power diesel trains, dishwashers, fans, and countless other things. But what exactly does an "induction" motor mean? In technical terms it means that the stator windings induce a current to flow into the rotor conductors. In layman's terms, this means that the motor is started because electricity is induced into the rotor by magnetic currents instead of a direct connection to electricity, like other motors such as a DC commutator motor.

What does polyphase mean? Whenever you have a stator that houses multiple, unique windings per motor pole, you are dealing with polyphase (Fig. 3). It is most common to expect a polyphase motor to be made up of three phases, but there are motors that utilize two phases.

A polyphase system uses multiple voltages to phase-shift apart from each one in order to go intentionally out of line.

What does three phase mean? Based around Nikola Tesla's basic principles defined in his polyphase induction motor put forth in 1883, "three phase" refers to the electrical energy currents that are supplied to the stator via the car's battery (Fig. 4). This energy causes the conducting wire coils to start to behave like electromagnets.

A simple way to understand three phase is to consider three cylinders, shaped in a Y formation, utilizing energy pointed toward the center point to generate power. As the energy is created, the current flows into the coil pairs inside the engine in such a way that it naturally creates a north and south pole within the coils, allowing them to act like opposite sides of a magnet.

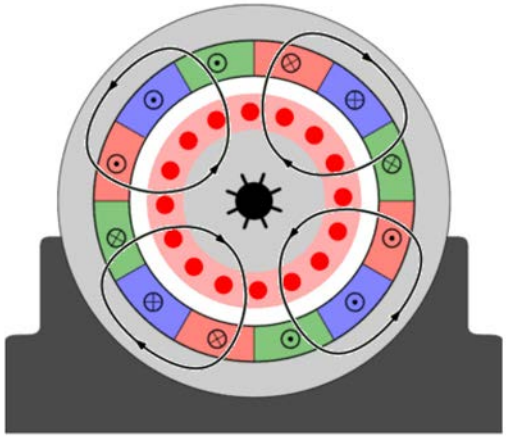


Figure 3 A polyphase system uses multiple voltages to phase-shift apart from each one in order to go intentionally out of line.

Top Performing Electric Cars

As this technology continues to advance, the performance of electric cars are starting to quickly catch up to, and even outperform, their gas counterparts. While there remains some distance for electric cars to go, the leaps that companies like Tesla and Toyota have made to this point have inspired hope that the future of transportation will no longer be reliant on fossil fuels.

At this point, we all know the success that Tesla is experiencing in the field, putting out the Tesla Model S Sedan that is capable of driving up to 288 miles, hitting 155 MPH, and has 687 lb-ft torque. However, there are dozens of other companies that are seeing massive progress in the field, such as Ford's Fusion Hybrid, Toyota's Prius and Camry-Hybrid, Mitsubishi's iMiEV, Ford's Focus, BMW's i3, Chevy's Spark, and Mercedes' B-Class Electric (Fig. 5).

Electric Cars and the Environment

Electric engines impact the environment both directly and indirectly at a micro and macro level. It depends on how you want to perceive the situation and how much energy you want. From the individual standpoint, electric cars don't require gasoline to run, which leads to cars with no emissions populating our highways and cities. While this presents a new problem with additional burden of electricity production, it alleviates the strain from millions of cars densely populating cities and suburbs putting toxins into the air (Fig. 6).

Note: The MPG (miles per gallon values listed for each region is the combined city/highway fuel economy rating of a gasoline vehicle that would have global warmings equivalent to driving an EV. Regional global warming emissions ratings are based on 2012 power plant data in the EPA's eGrid 2015 database. Comparisons include gasoline and electricity fuel production emissions. The 58 MPG U.S. average is a sales-weighted average based on where EV's were sold in 2014.

From a large-scale perspective, there are several benefits

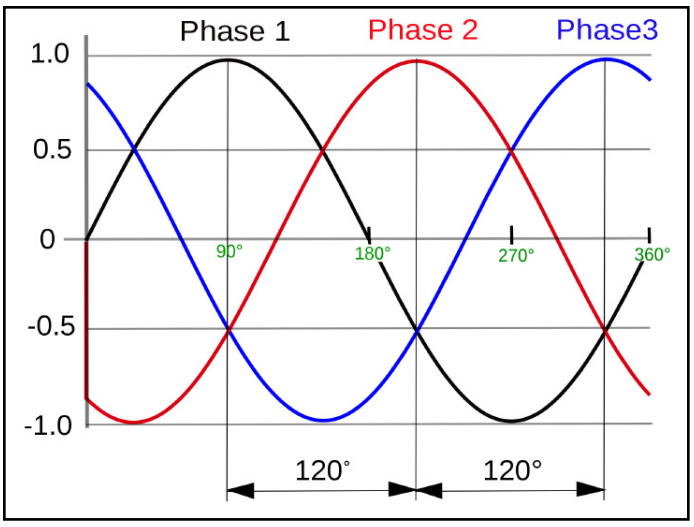


Figure 4 Three phase refers to the electrical energy currents that are supplied to the stator via the car's battery.

to the rise of electric cars. For starters, there is a reduction in noise pollution as the noise emitted from an electric engine is far more subdued than that of a gas powered engine. In addition, due to the fact that electric engines do not require the same type of lubricants and maintenance that a gas engine does, the chemicals and oils used at auto-shops will be reduced due to fewer cars needing check-ups.

Conclusion

The electric engine is changing the course of history in the same way that the steam powered engine and printing press redefined progress. While the electric engine is not paving new grounds in the same vein as these inventions, it is opening up a brand new segment of the transportation industry that is not only focused on style and performance, but also external impact. So, while the electric engine may not be reforming the world due to an introduction of some brand new

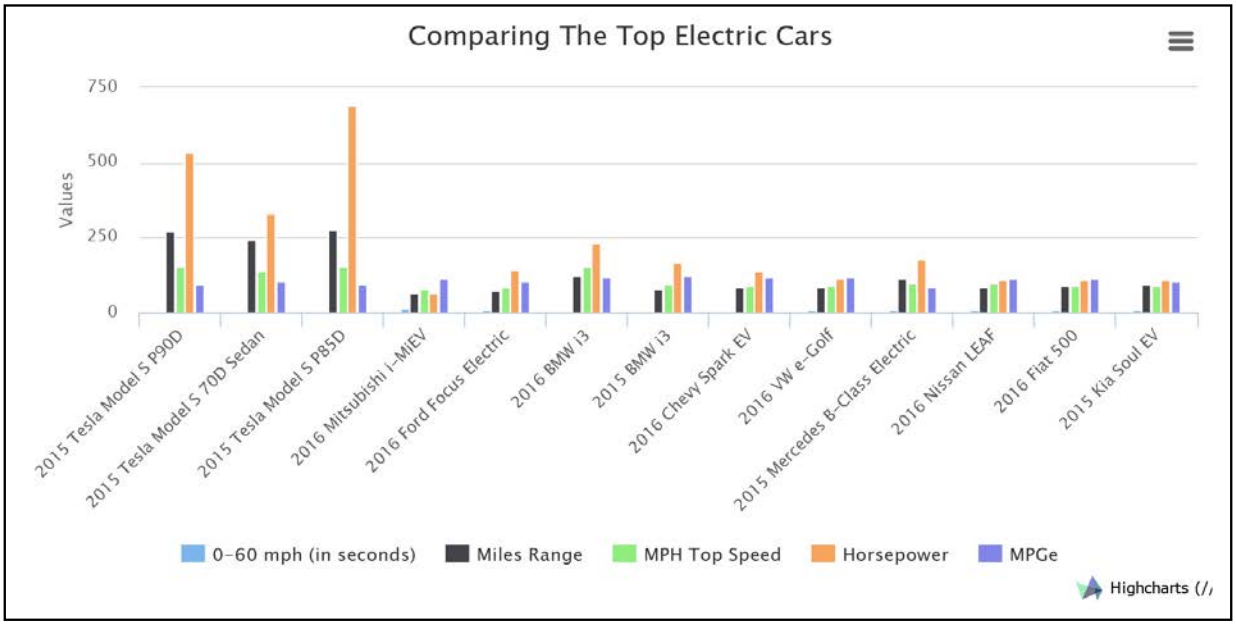


Figure 5 Dozens of other car companies are seeing massive progress in the field, such as Ford's Fusion Hybrid, Toyota's Prius and Camry-Hybrid, Mitsubishi's iMiEV, Ford's Focus, BMW's i3, Chevy's Spark, and Mercedes' B-Class Electric.

invention or the creation of a new marketplace, it is redefining how we as a society define progress.

If nothing else is to come from the advancements with the electric engine, at the very least we can say that our society has moved forward with our awareness of our environmental impact. This is the new definition of progress, as defined by the electric engine. **PTE**

(Jill Scott is business manager for SaveonEnergy; *SaveonEnergy.com*.)

For more information

SaveOnEnergy
6860 North Dallas Parkway, Suite 228
Plano, TX 75024
Phone: 1 (800) 279-5230
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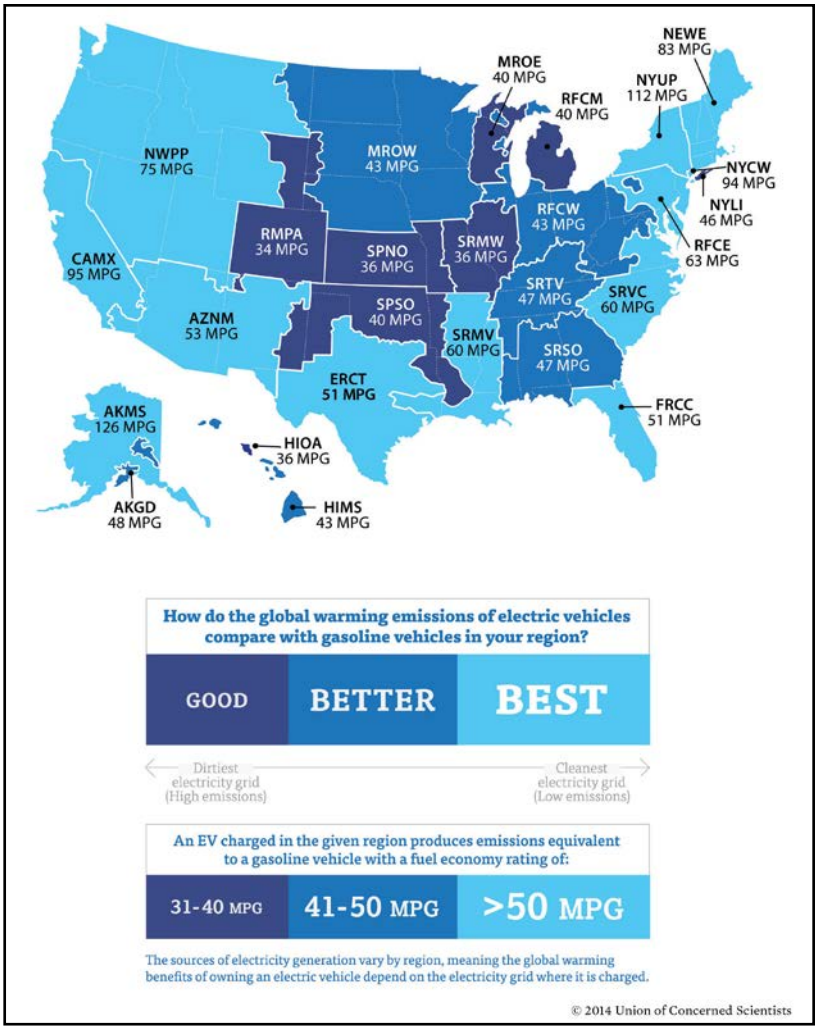


Figure 6 Miles-per-gallon values for each region of the country is the combined city/highway fuel economy rating of a gasoline vehicle that would have global warming's equivalent to driving an EV.

BSA Excellence Awards Take Place in Chicago

On Monday evening, September 26, 2016, BSA President, John Ruth, BDI, presented the very first Annual BSA Excellence Awards for outstanding service by bearing distributors and bearing manufacturers to the end use customer.

The Bearing Manufacturer Excellence of Innovation in Product Design Award recognizes companies for innovation and excellence in product design or technology. BSA distributor members reviewed and ranked manufacturer innovation submissions. Among the abundance of innovative product designs submitted, three submissions were chosen to be recognized for their outstanding service to the end use customer.

The first Manufacturer Excellence Award was presented to **Baldor - Dodge for the Ultra Kleen Ball Bearing.** The Dodge Ultra Kleen Ball Bearing features a stainless steel insert available in both polymer and stainless steel housings. The insert includes the patented QuadGuard seal and Maxlife cage which protects the bearing in extremely harsh environments and provides extended life. The combination of corrosion resistant features and advanced sealing make the Ultra Kleen bearing perfect for demanding applications found in the food and beverage industry. Ultra Kleen bearings can now be equipped with the new metal detectable end cover which further improves reliability and safety for users.

Chris Keyser, vice president — channel management and industry/packaged solutions accepted the award on behalf of Baldor Electric Company for the Baldor - Dodge Ultra Kleen ball bearing.

The second Manufacturer Excellence Award was presented to **Schaeffler Group for the FAG SmartCheck.** The FAG SmartCheck from Schaeffler is a condition monitoring device that fits in the palm of your hand. It is a compact yet powerful system that enables decentralized, permanent machine condition monitoring. Smaller than a baseball yet far more than a classic vibration measuring device, SmartCheck has its own internal network browser that enables monitoring and diagnostics from anywhere in the world. Combining an affordable price with a high degree of safety, SmartCheck delivers a full range of machine diagnosis and rolling bearing-related services.

With its FAG SmartCheck vibration measuring device, Schaeffler has taken condition monitoring to a whole new level of convenience and portability. It all comes down to avoiding costly downtime. But, don't let its compact size fool you! It is a fully self-contained online monitoring system. Perfect for monitoring equipment like motors, pumps, gearboxes, fans and so much more.

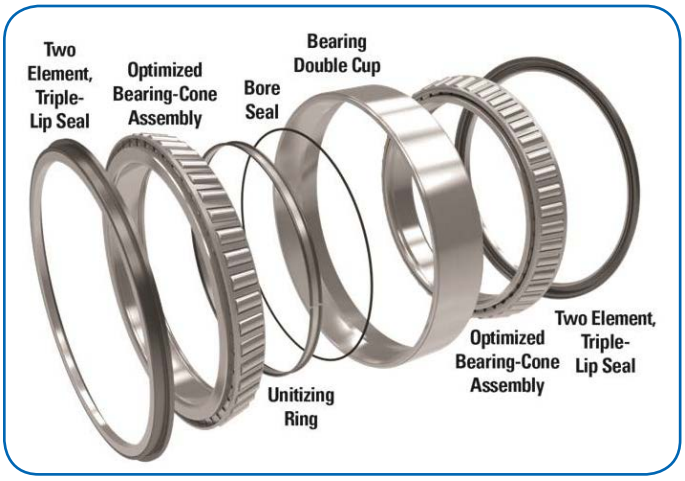
Think of SmartCheck as kind of like a machine doctor. Just attach it to your machine and it learns what the equipment should be doing when it's operating correctly, and alerts you when its health begins to change. Plus, with an available Schaeffler app, you can check the condition of your equipment right on your smartphone!

Kevin Kozlowski, vice president, industrial distribution Americas, Schaeffler Group USA, Inc. accepted the Award on behalf of Schaeffler Group for the FAG SmartCheck.

The third Manufacturer Excellence Award for outstanding service to the end use customer was presented to **The Timken Company for the Timken Sheave Pac Bearing Assembly.** The Timken Company introduced this product to help increase safety and improve uptime on oil rigs. The Timken Sheave Pac bearing assembly was designed to eliminate the need to re-grease the traveling block or crown block on oil rigs.

In the past, maintenance personnel performed the challenging task of re-lubricating the crown and traveling blocks situated hundreds of feet above the rig platform. The Timken Sheave Pac alleviates that job through its sealed-for-life sheave bearing assembly, helping to increase safety for rig workers and reduce expensive downtime.

The pre-greased, pre-set and unitized Timken Sheave Pac can eliminate the need for re-greasing the bearing because Timken engineers designed the bearing assemblies to run an entire operating cycle between rebuild without the need for re-lubrication or additional maintenance. The Sheave Pac assembly easily interchanges with current industry-standard bearing assemblies and seals.



The Sheave Pac bearing provides the rig operator increased profitability, efficiency and operational safety. These benefits result from the elimination of sheave grease maintenance, which increases block availability and the removal of placing personnel in dangerous positions associated with standard block grease maintenance.

Chris Coughlin, executive vice president and group president at The Timken Company, accepted this Award on behalf of The Timken Company for the Sheave Pac Bearing Assembly.

The 2016 BSA CBS Excellence Award recognizes BSA Distributor Companies with the highest percentage of their inside and outside sales force's having attained CBS status. 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.

On Monday night, BSA recognized three companies with Honorable Mentions for this Award. B&D Industrial, BDI USA and Motion Industries Canada Inc. received special recognition for the number of Certified Bearing Specialists within their sales force.

Both of the CBS Excellence Award winning distributor companies have over 20 percent of their total sales force holding CBS status. This award recognizes the esteemed regard of the CBS designation by these two companies specifically, and the industry as a whole.

The recipients of the 2016 CBS Excellence Award for outstanding service to the bearing end use customer are BDI Canada Inc. and Bearing Headquarters Company.

Bill Shepard, who is a Certified Bearing Specialist himself and is vice president southwest region and marketing for BDI USA accepted the award for BDI Canada. Jim Scardina who serves as the senior vice president of Bearing Headquarters Company accepted the award for Bearing Headquarters Company.

SMT

ANNOUNCES FORMATION OF SMART MANUFACTURING TECHNOLOGY JAPAN LTD.

SMT is proud to announce the formation of Smart Manufacturing Technology Japan LTD. (SMTJ), a subsidiary of SMT. The new office in Japan is the latest installment of the company's expanding reach worldwide.

A lot of Japan's excellent development and manufacturing companies in aerospace, automotive, bearing, marine, off-highway, rail and wind, were founded by engineers full of monozukuri spirit. That spirit will be the bedrock on which bonds will be built and nurtured between SMT and its customers. SMTJ will support these engineers and the Southeast Asia area from this new Japanese hub.

David Beedan, director at SMT, says "The opening of a new business unit on the Asian continent will substantially help keep close ties and build stronger relationships with our customers across the globe. With growth comes exciting opportunities and I have full confidence that the new and experienced team in Japan will deliver and exceed the SMT values."

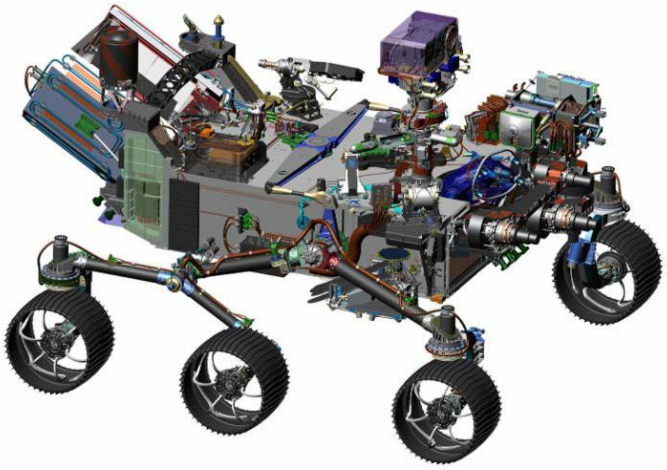
"As well as provide support and services to customers in Japan , the team will help open more doors to culturally proximate markets as well as provide greater access to sectors on the Australasian continent," he added.

PKB

AWARDED CONTRACT TO SUPPORT MARS 2020 MISSION

Pacamor Kubar Bearings (PKB), a Troy, NY manufacturer of ball bearings for aerospace and defense systems, was recently awarded a contract by Sierra Nevada Corporation (SNC) to supply critical hardware for the Mars 2020 mission.

Scheduled to launch in 2020, the robotic science rover will investigate key questions about the habitability of Mars and assess natural resources and hazards in preparation for future human expeditions to the red planet. Under the



new contract, PKB will manufacture ball bearings for several motors in the robotic arm actuator and sample caching system. The instruments will enable scientists to identify and select a collection of rock and soil samples that will be analyzed and stored for potential return to Earth.

"PKB has been supporting NASA's Jet Propulsion Laboratory (JPL) programs and missions for over 10 years," said Ed Osta, president of Pacamor Kubar Bearings. "We are grateful for NASA and SNC's continued confidence in our ability to produce reliable aerospace bearings for these vital missions. PKB is committed to the success of this mission and proud to partake in this project. We look forward to continuing our longstanding relationships with JPL and SNC."

PKB understands the unique challenges presented by aerospace and guidance applications. Temperature extremes and the vacuum of space create demanding requirements for the lubricant type and its ability to withstand the environment. To meet this demand, PKB is providing precise and reliable products in support of successful missions.

"SNC appreciates the PKB's commitment to deliver the promised product within the assured timeline" said Jason Priebe, vice president of productions/operations for SNC's Space Systems business area. "Reliable suppliers are crucial to developing a final product that you're proud to stand behind."

Power Transmission Engineering

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18. Signature and Title of Editor, Publisher, Business Manager, or Owner — Date: 9/30/16

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November 1–3—CanWEA Annual Conference and Exhibition Calgary, Alberta. Hosted by the Canadian Wind Energy Association (CanWEA) and Hannover Fairs (Canada), the conference will highlight wind energy commitments, opportunities and innovations across all regions of Canada. Additionally, this year's event will focus on Alberta and Saskatchewan's significant new renewable energy and climate change commitments.This year's Wind Energy Conference discussion topics include: asset management to maximize value, innovation: integration and interconnection into the grid, social aspects of wind development for emerging markets, latest developments and advancements in resource assessment, the future potential of wind energy storage and industry initiatives and advancements to reduce impacts on wildlife and specifically bat populations. For more information, visit *windenergyevent.ca*.

November 1–4—PTC Asia 2016 PTC ASIA is Asia's leading trade fair for power transmission and control and fluid technology as well as bearings, motors, and linear and sealing technologies. Industry 4.0 is evident at many exhibits: an entire hall is dedicated to Smart Manufacturing, and the company Unity and the German Mechanical Engineering Industry Association (VDMA) once again stage the Smart Manufacturing Forum. Companies such as Argo-Hytos, Bonfiglioli, ContiTech, Dichtomatik, Eaton, EMC, Lenze, NORD Drivesystems and NTN are among the exhibitors. Germany, Italy and South Korea promote small and medium-sized companies with country pavilions. Co-located shows include CeMAT Asia, ComVac Asia and Industrial Supply Asia. Approximately 80,000 visitors are expected in 2016. Hannover Milano Fairs Shanghai Ltd., Deutsche Messe's subsidiary in China, organizes the four fairs. For more information, visit *www.hannovermesse.com*.

November 11–17—IMECE 2016 Real world challenges that face health care, transportation, space exploration, new product design and manufacture, and energy require interdisciplinary mechanical engineering approaches and perspectives. ASME's International Mechanical Engineering Congress and Exposition (IMECE) is designed to facilitate this powerful dialogue between disciplines in the global engineering arena.IMECE has a long-standing history within ASME and the mechanical engineering field. Historically, IMECE has been the first place that new innovation in mechanical engineering is presented. For example, in 1911, Willis Carrier presented what many scientists consider to be the most significant document on air conditioning. The first proceedings of the 1st New York Meeting, now known as IMECE, were published in 1880. Since then, the conference has grown to include various audiences, and be the mark of innovation and interdisciplinary collaboration within the mechanical engineering field. The event features 20+ tracks and 240 topics in mechanical engineering, daily plenary sessions, industry presentations, an Honors Assembly program and more. For more information, visit *www.asme.org*.

November 15–17—Detailed Gear Design-Beyond Simple Service Factors Las Vegas, Nevada. This course explores all factors that go into good gear design from life cycle, load, torque, tooth optimization, and evaluating consequences. Students should have a good understanding of basic gear theory and nomenclature. Interact with a group of your peers and with a talented and well-respected instructor who will push your thinking beyond its normal boundaries. Gear engineers, gear designers, application engineers, people who are responsible for interpreting gear designs, technicians and managers that want to better understand all aspects of gear design should attend. Raymond Drago is the course instructor. *www.agma.org*.

November 29–December 1—Composites Europe 2016 Dusseldorf, Germany. Experience the entire process chain of the composites industry and gain a complete overview of the market and the major exhibitors - in just three days. As the international industry meeting point in Europe's biggest composites market, Composites Europe combines tried and tested solutions and efficient innovations. The trade fair reflects the variety of goods and services and the innovative strength of the entire industry. Major topics at the fair are state-of-the-art production and processing technologies focusing on concepts for lightweight construction and automotive applications. Industries involved include automotive, aerospace, energy, marine, electronics, medical, wastewater, agriculture and general engineering. For more information, visit *www.composites-europe.com*.

December 5–8—CTI Symposium 2016 Berlin, Germany. More than ever, the development of transmissions and drivetrains is being shaped by the trends of electrification, connectivity and automation. The focus rests on significantly increasing driving efficiency and comfort while reducing emissions, and on providing a brand-appropriate driving experience – as well as on 'ongoing demands' in terms of costs, package, weight and modularity. The planned introduction of regulations to measure Real Driving Emissions (RDE) in 2017 will heighten the technical challenges these criteria involve. The only way to meet the ambitious targets is by intelligent, effective transmission and powertrain integration. These and other topics will be front and center during the CTI Symposium Berlin 2016. For more information, visit *www.transmission-symposium.com*.

December 13–15—Power-Gen International 2016 Power-Gen International provides comprehensive coverage of the trends, technologies and issues facing the generation sector. More than 1,400 companies from all sectors of the industry exhibit each year to benefit from the exposure to more than 20,000 attendees. Displaying a wide variety of products and services, Power-Gen International represents a horizontal look at the industry with key emphasis on new solutions and innovations for the future. Conference sessions include energy storage, the digital power plant, emissions control, gas turbine technologies and more. For more information, visit *www.power-gen.com*.

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Making Shakespeare Shine

Maxon Motor U.K. sheds new light in theater application

Matthew Jaster, Senior Editor

New things are invented for theater lighting all the time and they're usually big, expensive technology-driven devices. It's the simple things that make you wonder, "Why didn't I think of that?" according to Ken Billington, lighting designer. The RSC Lightlock is a great example of this.

The RSC Lightlock was developed by Vince Herbert, head of the Royal Shakespeare Company's Lighting Department, to address the nagging problem of controlling heavy, remote-controlled spotlights. In the past, using flexible, lightweight support structures for these lights was out of the question (stopping the lighting system would result in the whole gantry swinging after each motorized movement).

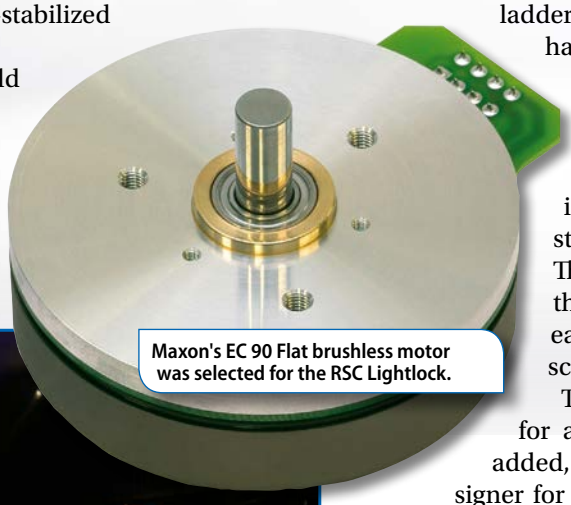
The Lightlock is a device for the entertainment industry that allows lights to be rigged on very lightweight, hanging or flown, structures. Essentially, it's a motion dampening device that can create a multitude of lighting solutions. It has been utilized in the Royal Shakespeare Theater in Stratford as well as concerts for the likes of Bon Jovi and Lady Gaga.

And it came to fruition as most engineering concepts tend to do with the simple question, "What if?"

One of Maxon 's customers CSM, a manufacturer of gyro's for the model helicopter industry, approached the motor company with an idea to provide a gyro-stabilized system based on inertial reaction torque.

"We were not certain how well it would work," said Paul Williams, sales engineer, Maxon Motor U.K. "We decided to build a unit to test the concept. CSM provided the gyro and electronics, Maxon provided the motor and RSC built the first lighting prototype."

The RSC Lightlock has been utilized in the Royal Shakespeare Theater in Stratford.



Maxon's EC 90 Flat brushless motor was selected for the RSC Lightlock.

Noise, dynamic performance and inertia were some of the key challenges in selecting the right motor for the lighting application, according to Williams. "The motor needed to be quiet and the drive needed to be thin. Our EC Flat motors are very compact and can generate high torque which is perfect for this application," he added.

They selected Maxon's EC 90 Flat brushless, multipole motor with an outer rotor design that generates high torques at slow speeds. The flat design is useful when space is limited. This same motor has been utilized in exoskeleton drives to power joints thanks to its low profile, high torque and power to weight ratio.

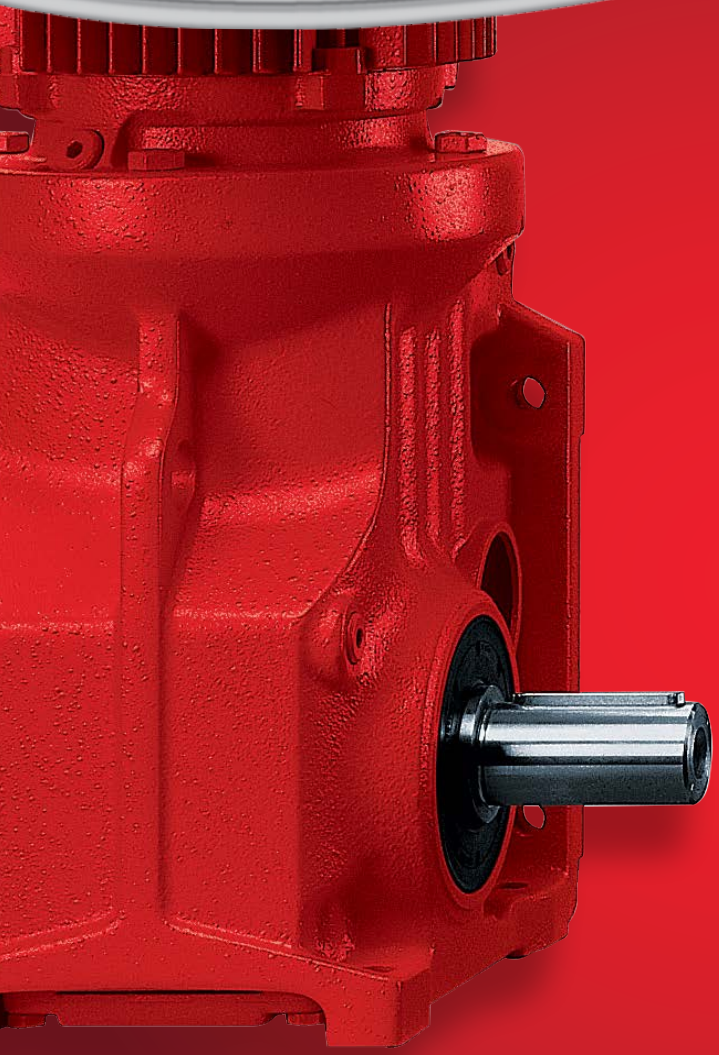
Before the RSC Lightlock, the only way to use large moving lights was to hang them from heavy-duty mounting infrastructures — which made accessing the lights a lengthy, dangerous and costly process.

When the RSC Lightlock needs to stop moving, a counterweight on an internal disc swings in the opposite direction to its movement, nullifying the momentum. Incredibly, the heavy counterweight necessary is rotated by the Maxon EC 90.

For creative lighting setups, the RSC Lightlock offers plenty of benefits. "On many of my shows there are flying ladders, and no matter how you hang them, the lights always end up swinging," Billington said. "Lightlock has solved this problem. By putting it on top of the light ladder, it keeps the ladder nice and steady while flying in and out. This prevents the audience from thinking that the show has an earthquake effect every time the scenery changes."

Tim Mitchell, lighting designer for a 2008 production of Hamlet added, "I've worked as a lighting designer for many years. I've always been frustrated by the limitations of traditional lighting solutions and am delighted that the RSC has designed this new product which will open up more flexible creative choices."

Williams is more than happy to be involved in the design phase of a motor application because it builds a closer relationship with his customers. "While we offer a standard product range, 60 percent of our products are modified to meet these unique applications." (*www.maxonmotorusa.com*) **PTE**



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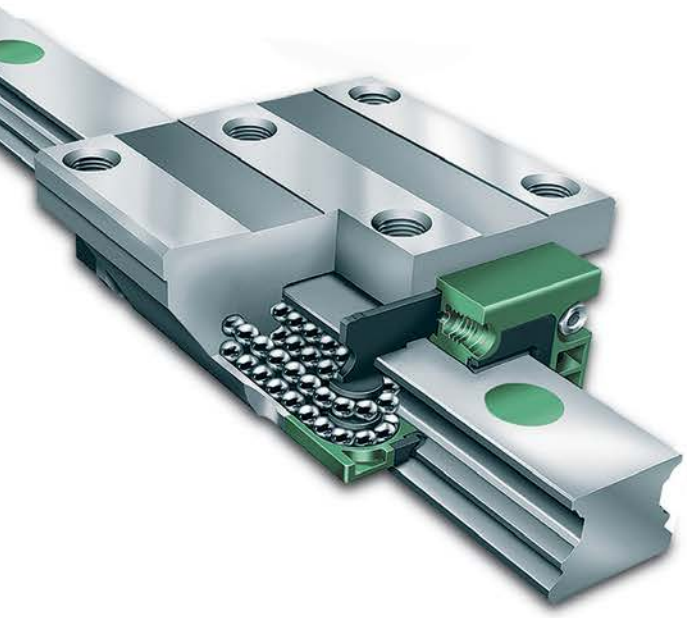

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