Power Transmission Engineering®

DECEMBER 2015

BUYERS GUIDE 2015

Your comprehensive directory of mechanical component suppliers

Affordable Power Transmission

high-quality components at low prices!

SureMotion

Synchronous Drives

AutomationDirect's new line of synchronous drive components provide the same positive timing action of gears or chains but with the flexibility and quiet running of belts.

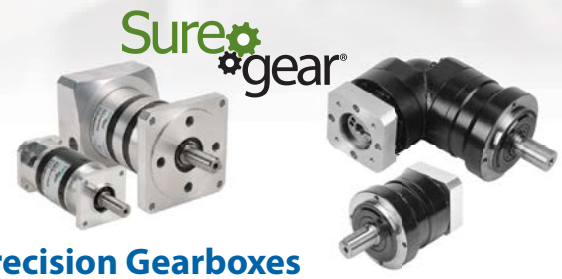
- Timing pulleys (sprockets) in both aluminum and steel are available in plain bore with setscrew or tapered bushing mounting styles.
- Timing (toothed) belt options include several popular pitches and widths and are made of fiberglass reinforced neoprene.
- Tapered bushings in both QD® and Taper-lock styles are available in most popular shaft sizes for mounting a variety of pulleys or sprockets to shafts.

Get dependable power transmission at low, low prices with SureMotion® synchronous drives!

Worm Gearboxes

IronHorse® worm gearboxes are manufactured in an ISO9001 certified plant by one of the leading worm gear reducer manufacturers in the world today. They are available in both aluminum and cast iron with a variety of frame sizes and ratios. Dual shaft, right hand shaft, and hollow shaft options are offered and come with a one year warranty.

- Aluminum gearboxes start at $88.00
- Cast Iron gearboxes start at $147.00



Precision Gearboxes

The SureGear® PGCN series is an exceptional gearbox for servo, stepper, and other motion control applications requiring a NEMA size input/output interface. Available in NEMA 17,NEMA 23 and NEMA 34 frames sizes with a wide range of ratios, a 20,000 hour service life, and a one year warranty.

The SureGear® PGA and PGB series of high-precision servo gear reducers are excellent choices for applications that require accuracy and reliability at an exceptional value. The PGA series is an in-line configuration while the PGB series is a right-angled reducer. Both provide a level of precision and torque that is best in class and come with a five year warranty.

- SureGear small NEMA motor gearboxes start at $209.00
- SureGear servomotor gearboxes start at $398.00

Research, price, buy at: www.automationdirect.com/power-transmission

Order Today, Ships Today!

VOTED Best in SERVICE 15 YEARS 2001 - 2015

AUTOMATIONDIRECT.com

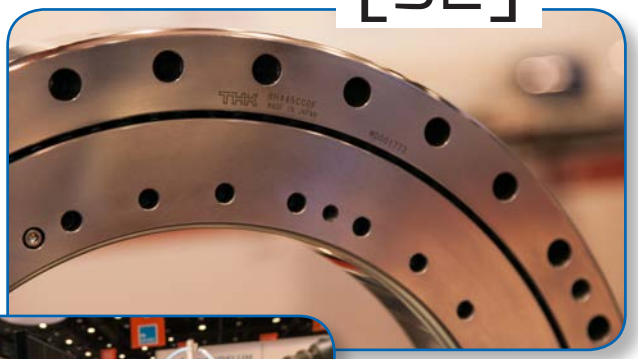
1-800-633-0405

the #1 value in automation

Power Transmission Engineering®

DECEMBER 2015

[32]



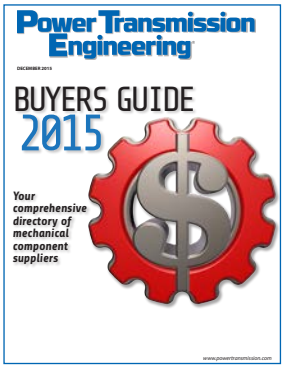
FEATURE ARTICLES

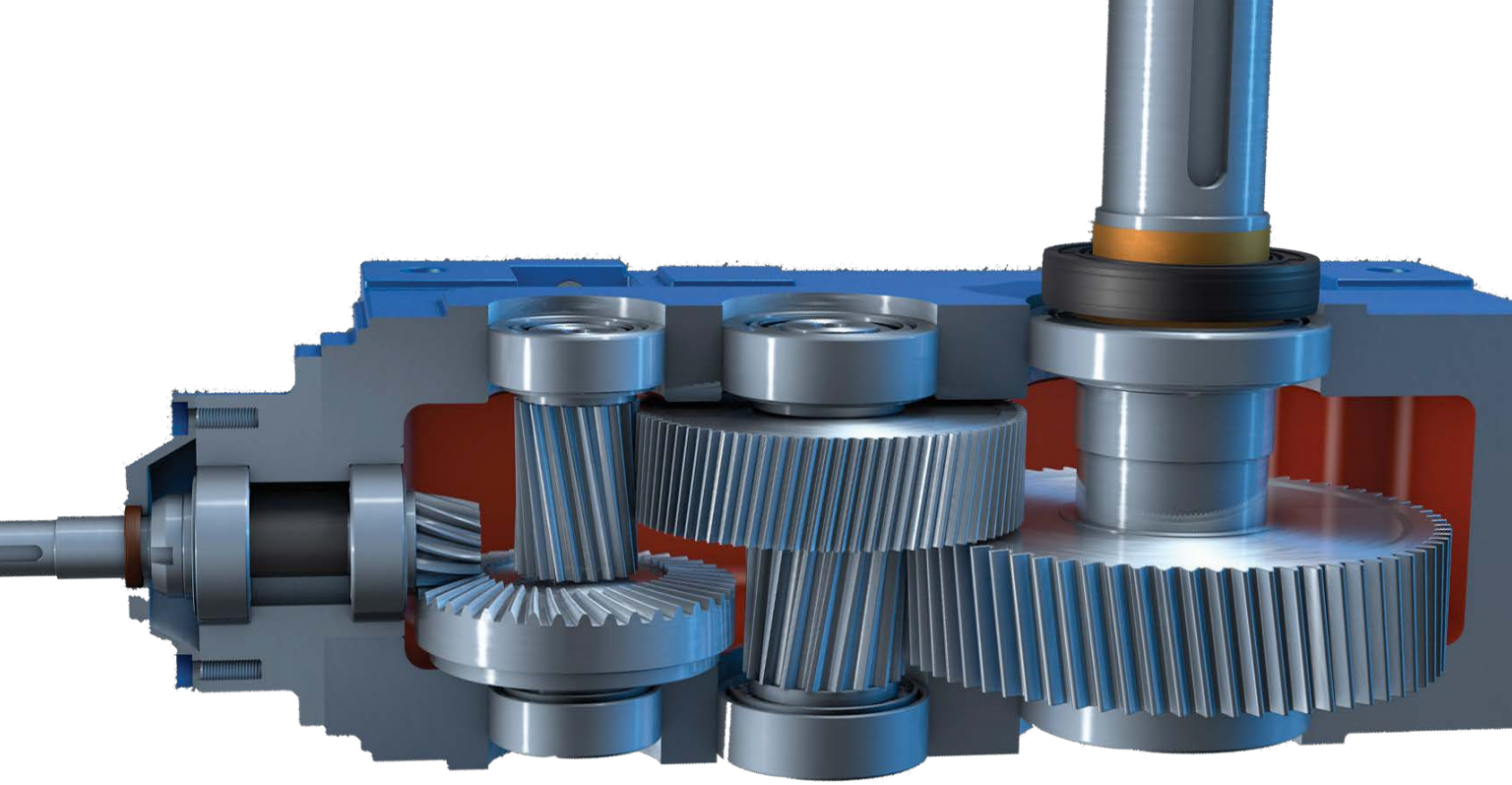
TECHNICAL ARTICLES

Vol. 9, No. 8. 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. 9, NO. 8





Driving driveline performance

Whether you are designing gearboxes or using them to drive your operation, SKF can help you improve performance and reliability.

Solutions range from automatic lubrication systems to more effective seals and upgraded SKF Explorer spherical roller bearings that reduce friction and increase torque.

For more information about SKF solutions for industrial transmissions, including condition monitoring services and complete gearbox remanufacturing services available at dedicated centres worldwide, visit **skf.com**.

SKF Explorer bearings

SKF CircOil circulating-oil centralized lubrication system

SKF sealing solutions

The Power of Knowledge Engineering

SKF®

www.powertransmission.com

SKF Secures Marine Contract

SKF is supplying China Oilfield Services Limited (COSL) with propulsion shaft components and application engineering services for its new-build fleet of offshore supply vessels. 16 propulsion shafts on eight vessels will be equipped with SKF components. ***www.powertransmission.com/news/6835/SKF_Secures_Marine_Contract_/***

Gear Talk

Chuck Schultz, *Gear Technology* technical editor and overall gear guru, continues to offer his insights at our sister publication's website. Visit the *Gear Technology* blog for his latest discussion on evaluating business opportunities within the gear industry: ***www.geartechnology.com/blog.***

MDM West

More than 2,000 suppliers of the latest medical technologies will be exhibiting at the Medical Design & Manufacturing West Expo taking place in Anaheim, CA, February 9-11, 2016. Presentations include new product developments, mobile health technologies, smart manufacturing and micro-technologies. For more information, visit ***www.mdmwest.mddionline.com.***

Stay Connected

Follow us on Twitter
twitter.com/#!/PowerTransMag

Connect with us on LinkedIn
www.linkedin.com/groups/Power-Transmission-Engineering-PTE-2950055

Subscribe Online
www.powertransmission.com/subscribe.htm

Power Transmission Engineering

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

BPA WORLDWIDE SM BUSINESS


Wishing You a Merry Christmas
(And a Little Mistletoe)...
From Forest City Gear
FOREST CITY GEAR
11715 Main Street, Roscoe, IL 61073
815-623-2168
www.forestcitygear.com
The Christmas Season reminds us to pause and give thanks for the many gifts we've received throughout the year. We're blessed with great customers and a skilled and dedicated family of employees – and the joy that comes from doing good work in the business we love.
We look forward to helping you achieve all your gear desires in 2016.

Randy Stott, Managing Editor

Don't Blink

Sometimes I feel like I blink and another year is gone. By the time most of you read this, it will be at or near the end of 2015. If you're like us, you'll be reflecting on the past year and looking forward to the next.

I'd like to thank everyone who has contributed to our success in 2015. That includes our many advertisers, without whose support our efforts wouldn't be possible, as well as our authors, whose desire and willingness to share their knowledge and experience make this magazine an educational resource instead of just a trade magazine. Here at *PTE*, we've had a really productive, transformative year, with significant changes, improvements and growth.

Our website and digital offerings are one example. In 2015, we completely redesigned *www.powertransmission.com*, making it accessible to readers no matter if they're sitting at their desks, using tablets on the factory floor or surfing on their phones. We've spent a lot of time and effort integrating the various areas of our site so that when you visit and find something you're interested in, you'll be sure to see related content that helps you keep exploring. We added "The Bearings Blog," written by Norm Parker, who is a bearing technical specialist with the driveline division of General Motors. His contributions, both online and in print, have greatly expanded the technical discussion and educational material we provide.

Also, in 2015, our publication became a member of BPA Worldwide, which means that our magazine's circulation is audited annually. This forces us to keep detailed records on our subscribers, including when each person last subscribed and how each person is involved with power transmission and motion control components. In turn, this helps us fine-tune our editorial content to ensure that we're delivering the information that you need most. It also means that we need to continually renew your subscriptions. We know you're busy, but if you haven't filled out a subscription form in the past year, we'd sincerely appreciate if you'd go to *www.powertransmission.com/subscribe.htm* to fill one out today.

Of course, 2015 was a Gear Expo year, and because gears are such an important part of what we do here, our booth at the show gave us an opportunity to share knowledge with a wider audience. For the first time ever, we offered Ask the Expert Live, and the sessions – all focused on gears – were a huge hit. You can visit our sister site to see the recorded sessions on gear design and other gear-related topics. Just visit *www.geartechnology.com/videos/* to see them.

We've also added significant staff in 2015. Over the course of the past six months you've read articles from Alex Cannella, who joined us as News Editor in June and who is making solid contributions not just to our news departments, but also as an editor and feature article writer (see his article on Industry 4.0 beginning on page 24). We're also pleased to announce that Senior Editor Matt Jaster has rejoined our staff after being away for a little more than a year. If you have any ideas about articles that should appear in *Power Transmission Engineering*, I invite you to contact Matt directly (mjaster@powertransmission.com), because he's eager to get reacquainted with many of you and develop articles for 2016.

Speaking of which, we've got a lot planned for next year. You'll definitely see some changes in the magazine, with new features, departments, special columns and focus issues. We're keeping a lid on the specifics for now, but rest assured that we're going to continue our path of growth, change and improvement in 2016.

So don't blink, because I guarantee that next year is going to fly by, too.

Small Mechanical Components – ONE CONVENIENT SOURCE

SDP/SI

STOCK DRIVE PRODUCTS
STERLING INSTRUMENT

REGISTERED ISO 9001 AS 9100

Timing Belts and Pulleys
Precision Gears
Gearheads
Bearings
Clutches and Brakes
Couplings & Universal Joints
Shafts, Shaft Accessories & Hardware

Technical Support
Online Calculations
Coupling Selector Tool
Download 3D Models
Get Your Free Catalog

Over 130,000 standard items

Phone: (800) 819-8900
Fax: (516) 326-8827

www.sdp-si.com

Designatronics Inc.

Engineered Solutions for a World in Motion

SKF EnCompass Field Performance Program

SHOWCASED ALONGSIDE NEW PRODUCTS AT PTC ASIA 2015

SKF recently presented a selection of its products and solutions at PTC Asia 2015 in Shanghai, China, from Oct. 27-30.

This year, SKF demonstrated the new SKF EnCompass Field Performance Program and a range of solutions for industrial electric motors, elevators, centrifugal compressors, gearboxes, remote diagnostics and other products.

New small sealed SKF Explorer spherical roller bearings with improved performance were one of SKF's exhibits at this year's PTC. The bearings prolong service intervals and needs for relubrication for gearless traction motors and reduce environmental impact. The range of bearings uses a new seal design, given the designation 'RS', which reduces overall friction in the bearing by up to 20 percent. In representative running conditions, this translates into calculated annual energy savings of up to 145 kWh. For a typical gearless traction motor in a heavy-duty elevator, replacing two sealed SKF Explorer bearings with the newly optimized design could cut CO_2 emissions by up to 100 kg annually. Over the motor's lifecycle, it can add up to a two-ton reduction in CO_2 emissions.

The new small sealed SKF Explorer spherical roller bearing is part of the SKF EnCompass Field Performance Program. This program provides users with a more detailed analysis of the factors that influence bearing service life and enables users to optimize bearing selection and design for improved performance in real-world conditions.

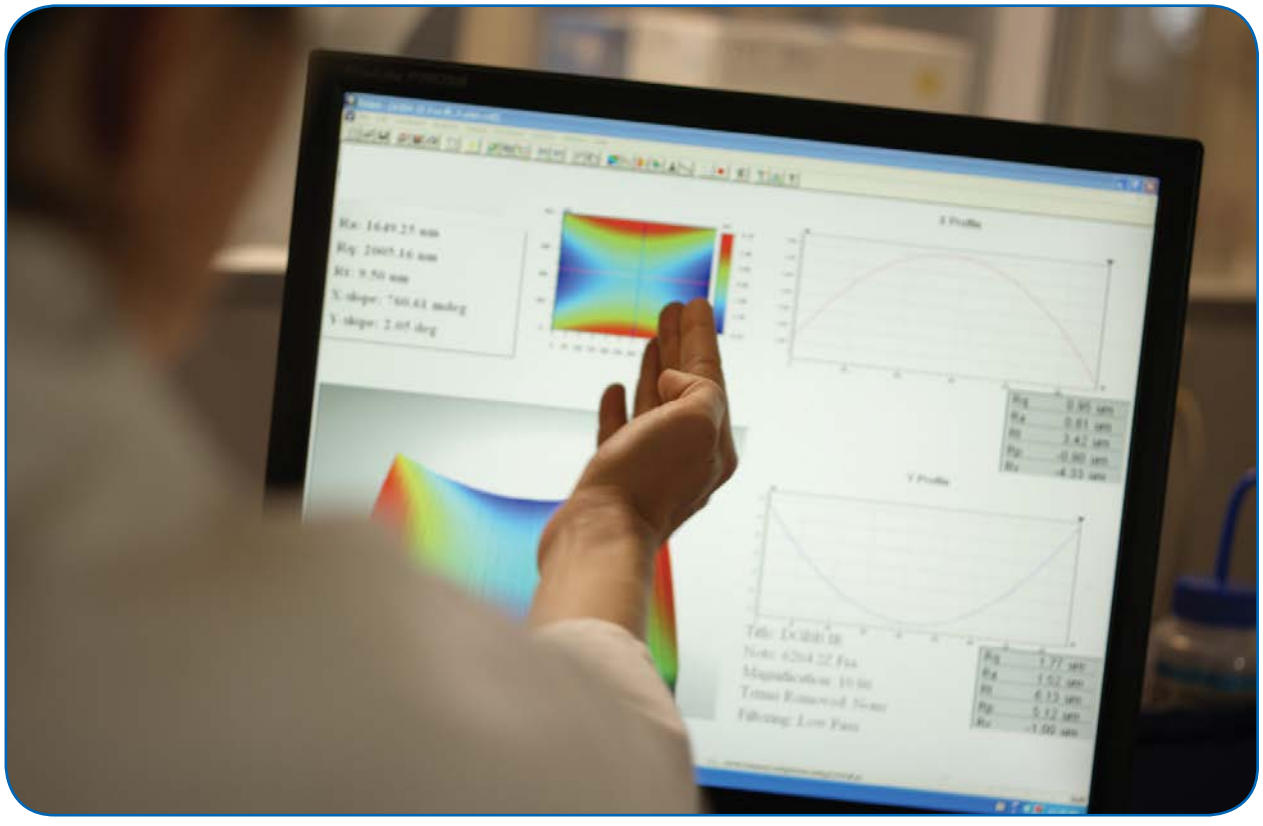
Also on display were the new oil-free pure refrigerant lubricated bearings for centrifugal compressors in chillers. The new bearings are an oil-free solution for direct drive centrifugal compressors in chillers that use low-viscosity refrigerant as the bearing lubricant.

SKF also showed off a new magnetic system, an oil-and contact-free drive for centrifugal compressors in chillers. Combining a high-speed permanent magnet motor and active magnetic bearings with integrated controls, the magnetic system can operate with variable speed drives from various manufacturers to deliver energy savings of at least 10 percent versus conventional centrifugal compressor designs. This technology also reduces maintenance costs for the users and provides them with reliable and cost-effective air conditioning.

SKF's HRS seals were also shown at the exhibition. The new generation HRS seals can extend the service life of heavy-duty equipment operating in difficult conditions, and are manufactured in a full range of standard sizes to suit heavy-duty applications in a range of industries, including wind energy, cement manufacture, mining and tunnel boring equipment.

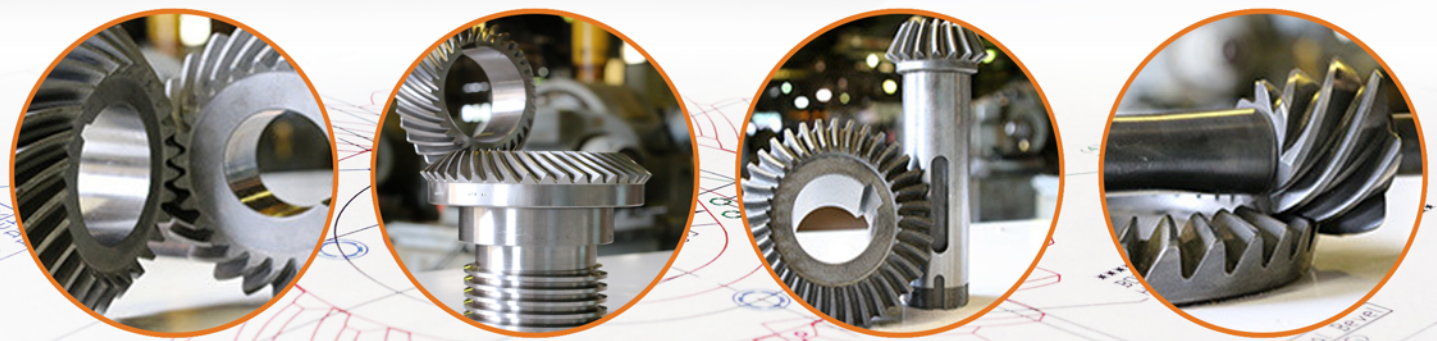
SKF also demonstrated their SKF Insight technology, which enhances bearing condition monitoring management in the railway and wind power industries. SKF Insight creates a cost effective way of collecting condition monitoring data so that bearing life and change-out intervals are determined based on real operating conditions.

For more information:
Phone: (267) 436-6000
www.skf.com/us



Gearing your past to power your future.

Quality precision with every process.



Breakdown Services

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

EPC Model 30M

DESIGNED TO PROVIDE ACCURATE INCREMENTAL FEEDBACK IN HARSH CONDITIONS

Encoder Products Company (EPC) recently introduced the all new Model 30M, a low-profile 30 mm diameter magnetic encoder module. The Model 30M is designed to provide accurate incremental feedback, even in harsh operating conditions, by means of advanced sensing and signal processing technology.

The Model 30M combines a hall-effect sensor, advanced signal processing circuitry and a small, powerful magnetic target, which can be affixed to a rotating shaft via an optional shaft adaptor or insert. With a wide sensor-to-magnet air gap and high waveform symmetry and repeatability, the Model 30M tolerates shaft misalignment and delivers high-quality signal accuracy.

Designed for high-performance applications, the Model 30M offers resolutions up to 1,024 CPR, a maximum frequency of 350 MHz, up to 8-pole commutation, an optional index channel, two voltage selections and four output types. Connector options include an 8-pin M12, or an 8-pin or 16-pin Molex with an integral strain relief. An optional centering and gap-setting tool enables quick and easy installation.

Resistant to dust, dirt, and moisture, the Model 30M features a chemically inert high-temperature nylon housing and non-contact magnetic sensing. The encoder is capable of operating in temperatures ranging from -40C to 120C and can be sealed to IP69K. With a sensor-to-magnet air gap of 0.022", the Model 30M holds ratings of 100 g at 11ms for shock and 20 g at 10 to 3000 Hz for vibration.

The Model 30M is a cost-effective solution for non-contact, end-of-shaft rotary feedback in commercial, industrial and non-industrial applications. Some examples are servo or stepper motor control, mobile equipment speed and steering sensing, timber processing machinery, studio and stage equipment, solar panel positioning, vending machines, rotary valve positioning, punch presses and robotics.

For more information:
Phone: (800) 366-5412
www.encoder.com

New KISSsoft Feature

CONSIDERS COMPLIANCE AND INFLUENCE ON LOAD DISTRIBUTION IN THE GEARBOX

In the static system analysis, a new feature considers housing compliance and influence on load distribution in the gearbox as well as load reaction force iteratively (module KS4). A stiffness matrix for housing is imported for this calculation. This stiffness matrix is generated from an FE calculation such as ANSYS, ABAQUS or similar.

The resulting shaft displacements cause a misalignment of toothing and therefore have an effect on the gear optimization, in particular when resilient housings and high forces are involved.

A reference project using the example of a shifted transmission of a motorcycle manufacturer in cooperation with the company CADFEM was recently presented at the KISSsoft User Meeting 2015 and can be requested, in case of interest, as power point presentation (in English) at info@KISSsoft.AG.

For more information:
Phone: (815) 363-8823
www.kisssoft.ch

ARROW GEAR COMPANY

ARROW VISION

SEE IT IN YOUR RESULTS

THE ARROW GEAR STOCK PROGRAM

NOT YOUR AVERAGE STOCK GEARS

What makes Arrow's stock gear product line so unique? It's the level of precision. All Arrow stock spiral bevel gears are produced the same way we manufacture gears to meet the demands of the aerospace industry – with precision machining, precise inspection and high quality assurance.

What's not unusual is the many ways our customers use them. Whether they need to speed prototyping, improve lead time or find a cost-effective alternative for low production volumes, our stock gear program gets them there faster – at a lower cost.

See it in your results.
Download our Stock Gear Catalog at arrowgear.com/catalog

2301 CURTISS STREET, DOWNERS GROVE, IL 60515 | 630-969-7640 | ARROWGEAR.COM

National Instruments and Bosch Rexroth

COMBINE CONTROL HARDWARE COMPACTRIO AND PROGRAMMING ENVIRONMENT LABVIEW

National Instruments and Bosch Rexroth recently introduced a control and drive solution at this year's NI-Week conference.

The advantages of the control hardware CompactRIO and the programming environment LabVIEW are combined with servo technology. Rexroth's pre-configured drive systems for measuring and testing machines cover a wide range of services and shorten the initial commissioning to just three minutes by means of a software wizard. Using a jointly tested and proven interface, machinery manufacturers are programming motion sequences in the graphic environment LabVIEW without any PLC code.

National Instruments frequently uses the control hardware CompactRIO in these applications. Rexroth has preconfigured drive systems with the compact drive control devices IndraDrive Cs and the servo motors IndraDyn S. The IndraDrive Cs kits cover the torque range from 0.56 Nm to 19.8 Nm in finely scalable increments. In addition, Rexroth supports custom drive solutions for torques up to 631 Nm.

Using the interface CAN over EtherCat, the CompactRIO control directly accesses the servo drives as master. Manufacturers can program processes and motion control via the graphical programming environment LabVIEW exclusively, making any additional PLC programming redundant. The plugin SoftMotion Drive Interface (SDI) required for IndraDrive Cs can be downloaded and installed directly from the LabVIEW development environment.

The start-up assistant EasyWizard shortens the initial start-up of the drive systems to just three minutes. The intelligent drive control device automatically recognizes the respective values via the electronic nameplate of the Rexroth motors. For the initial start-up of IndraDrive Cs drives, the user only needs to enter a small number of application-specific values. Graphical programming of movements can then start right away in LabVIEW.

The IndraDyn S synchronous servo motors can meet the requirements of protection class IP54 or IP65. Depending on the precision required, the motors are equipped with encoder systems for standard or precision requirements.

CompactRIO is particularly suitable for point-to-point movements in applications with a small number of axes. Bosch Rexroth simplifies the implementation of complex multi-axis applications with measuring and testing machines in LabVIEW using the Motion-Logic-System, IndraMotion MLC. Programming of movements can also take place exclusively via LabVIEW without a single line of PLC code. For IndraMotion MLC, more than 550 virtual tools and modules are already available for movement control in LabVIEW.

For more information:
Phone: (800) 739-7684
www.boschrexroth.com

Muncie Power Products MB and MJ Line Motors

FEATURE LOW SPEED, HIGH TORQUE AND 23 DIFFERENT SIZES

Muncie Power Products, Inc. recently announced the release of its new line of low-speed, high-torque motors.

Featuring the MB and MJ Series, the new line offers 23 different displacement sizes between the two series. A spool valve design (MB) and disc valve design (MJ) allow each series of Muncie Power's motors to achieve high efficiencies across a broad torque range.

With gerotor (MB) and roller gerotor (MJ) design options available, the low speed high torque motors meet a variety of application needs. Built for quality performance, the new motors are designed for industrial and mobile applications.

Muncie Power's motors are backed by customer service representatives ready to assist customers in using their motor to its maximum capability.

For more information:
Phone: (800) 367-7867
www.munciepower.com

Maxon Motors GP 6 S Spindle Drive

DESIGNED FOR COMPACT SPACES

Maxon Motors recently introduced the GP 6 S, a micro spindle gear drive with a diameter of 6 mm that is now also available in a metal version to provide a spindle drive with optimized value.

Spindle drives are designed for linear positioning systems, lens adjustment, or syringe pumps. Maxon Motor's GP 6 S spindle gear is meant for use in compact spaces. To provide a cost-effective alternative to the ceramic version, it is now also available with a metal spindle.

The GP 6 S spindle gear drive is designed for a wide variety of linear drive solutions. The maximum feed velocity is 15 mm/s at a force of 10 N. Integrated ball bearings ensure that this drive stands up to high axial loads. The gear drive can combine with the Maxon DC brushed motor (RE 6) and DC brushless motor (EC 6).

For more information:
Phone: (508) 677-0520
www.maxonmotorusa.com

Catalyst Motion Group Z-Theta System

COMBINE ROTARY AND LINEAR MOTION IN ONE UNIT

Catalyst Motion Group recently created a Z-Theta system utilizing in-house branded products. Z-Theta systems offer a compact and effective package to achieve a rotary axis and a linear axis in

Rexnord Autogard 820 Series Torque Limiters

IMPROVED WITH NEW REMOTE-RESET FEATURE

Rexnord's Autogard 820 Series Torque Limiter is now available with the option to Remote-Reset, an option that is suited to applications where the control center and the equipment are a considerable distance apart or the Autogard Torque Limiter is positioned behind complex guards and covers. From its disengaged position, the Autogard 820 Series Remote-Reset (RR) Torque Limiter can be reset in seconds using pneumatic controls without the need to physically approach the unit.

The Autogard 820 Series Torque Limiter is designed for high-torque applications in heavy-duty industries, including energy, metal processing, mining and aggregates, automotive, food processing, and pulp and paper to help protect equipment during shock loads, overloads and jams. Providing full disengagement on overload, torque limiting "modules" are positioned at a large radius to accommodate high-disengaging torques.

For more information:
Phone: (414) 643-3000
www.rexnord.com

a single unit that, when operated in coordinated motion, can create a helical motion path.

Z-Theta systems can also be used to move to defined linear positions, and then perform independent rotary moves. The Kerk brand ScrewRail is the centerpiece of this development, with the linear and rotary power being supplied by Haydon and Pittman motor technology.

Z-Theta systems are designed for picker type applications in automated kiosks, data storage libraries, and other repetitive motion tasks requiring both linear and rotary motion. Loads of up to 100 pounds and speeds in excess of 10 inches/second are possible.

The Catalyst Motion Group Z-Theta solution is fully customizable and adaptable to a broad range of specific design requirements, providing an innovative and effective solution.

For more information:
Phone: (203) 725-3852
www.catalystmotiongroup.com

Applied Motion SV200 Series Servo Drives

FEATURE PROGRAMMABLE NOTCH FILTERS, ANTI-VIBRATION FUNCTION AND AUTO-TUNING

Applied Motion recently introduced its newest line of all digital servo drives, the SV200 Series.

These servo drives offer programmable notch filters, an anti-vibration function and auto-tuning. Auto-tuning, drive configuration and programming are done within the SVX Servo Suite software, which, like all Applied Motion software, is available as a free download from their website. When paired with J Series servomotors, SV200 servo drives provide accurate and dynamic motion for demanding applications.

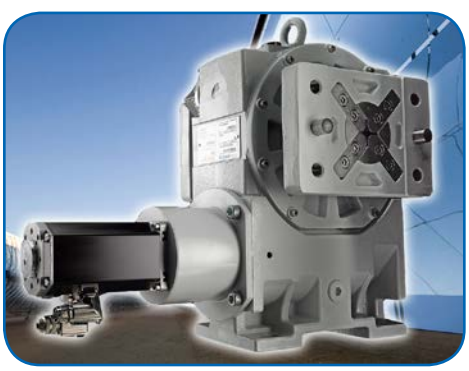
A wide range of control options are available from basic pulse and direction and analog torque/velocity control, to streaming commands and stored program execution. Networking options include Ethernet, RS-232/485, Modbus RTU, EtherNet/IP and CANopen.

For more information:
Phone: (831) 761-6555
www.applied-motion.com

Framo Morat Drives

DEVELOPED AND MANUFACTURED FOR RELIANCE POWER SOLAR PLANT

In April 2012, the Indian operator Reliance Power, India entrusted Areva Solar with the construction of a 100 MW Concentrated Solar Power (CSP) plant. Reliance Power operates coal, gas, water and renewable energy power plants supplying a total of 5,285 MW. The total of 1,524,600 square meters of Fresnel mirrors are controlled by close to



4,500 drives developed and manufactured by Framo Morat.

Framo Morat won the contract thanks to a successful design proposal — and the know-how gained from many other green energy projects. The order was placed in December 2011 and series production started already in August 2012. This period was used to develop the design concept to a series product, procure globally high-quality components and bought-in parts, and set up a brand new assembly line including the testing stand. Last but not least, a relatively complex logistics concept had to be developed to ensure the smooth transport from Framo Morat to the plant in Rajasthan.

Within one year (from August 2012 to August 2013), almost 5,000 drives have been supplied to India and to two projects in the USA. A single drive controls six reflectors with a total mirror surface of 330 square meters. With a weight of approximately 75 kg and outside dimensions of about 480 × 410 × 240 mm (H × W × D), the drive is both compact and robust.

Motion is ensured by a 400 W brushless DC motor provided with a CAN-Bus interface for central control. This motor is connected to a planetary gear developed especially for this control, which supplies an integer gear ratio in all three stages. The following worm gear set has been designed with an extremely low backlash in order to ensure the required positioning accuracy at the output shaft. The integrated absolute encoder with SSI interface measures the accuracy of the drive thanks to a specially developed arrangement of backlash-free gearwheels on the encoder shaft and on the output shaft, therefore offering the possibility of an individual re-adjustment by the control.

The interaction between positioning accuracy on the one hand and torque on the other hand was one of the challenges of this project. The required torque entailed a relatively high reduction ratio, for this reason, the necessary accuracy could only be achieved using highly accurate toothed components with extremely low backlash.

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

FEATURE

Chains and Belts Play to Their Strengths

If it has to move — or be moved — (steel) chains and (synthetic) belts remain integral part of any motion system.

Jack McGuinn, Senior Editor

Belt or chain — which is an integrator to pick?

As with just about everything else in the manufacturing world — and all which that universe entails — it depends. After all, that's why the art of manufacturing is a *process* — not a one-system-fits-all discipline. Yes, once that process has been properly designed and correctly implemented for a given manufacturing production need, it may well run like the fastest, smoothest cookie-cutter-type operation ever devised.

"Process" suggests a system with a combination of parts, components, etc. The process is the end product of these things.

Two of these "things" are typically as important to that process as any other part, component or software suite — i.e. roller chain and synchronous belt technology. From straight-shot conveying systems to heavy-duty power transmission, or from clean-room-type production to oil field rigs — belt and chain drives are integral to their reliable operation.

As you might expect, there are significant differences between the two, with steel chains around since Samson was dating Delilah — thus owning the "mature technology" tag. Synthetic synchronous belts are the relative technological newcomer on the block, first appearing around the mid-1940s and more or less growing up with modern motion technology. As with many technologies, application — and cost — determine what goes where.

If you are a system integrator, it will typically fall to you to make that determination. How tough is it? We asked Nick Antonelli, senior engineer for Nordex Inc.

"In today's world there are many factors that influence the decision on whether to use belts vs. chain drives. Many of these factors were not as important or not even considered just a few years ago. Speeds, accuracy, safety, environmental and even noise factors now take a high prominence in the modern decision-making process — along with the age-old factors such as power, direction of rotation, how many axes are to be powered by the drive device, etc. Belts have improved a lot in recent years; so have chains and their method of lubrication. In our experience, we notice that belts are the preferred method in most modern applications for precision drives. The method of drive enters into the equation as soon as the driven axis is determined."

We put the same question to Chuck Briere, national sales manager for Peer Chain Company.

"Chain versus belt is the first thing a designer needs to consider," he says. "For a drive application in HVAC, V belts make sense. Belts are friction and can handle high speeds smoothly. Many air movement systems depend on high volume air flow." Briere adds that speeds of 3,600 RPM are better suited for belts. Also, the fact that belts are a friction technology means that in the event of an overload, belts will slip and avoid system damage.

"For applications in conveyor transmissions or to develop torque, chains make better sense," Briere says. "Conveyors are much slower—under 350 RPM on the driver. Chains can be used with a wide selection of sprocket ratios to help the designer achieve the desired speed. The demand for torque gives chains an advantage due to mechanical ratios and the need for a positive drive."

And, say Michael Hogan, senior roller chain design & applications engineer, and Eduardo Manta, roller chain design & applications engineer for U.S. Tsubaki Power Transmission LLC, "As a system integrator he may begin thinking about a chain at any time because it is so versatile and easy. Chains are excellent for a range of speeds and

Figure 1 A lumber mill roll case requiring careful synchronization and smooth operation for stacking of boards got what it needed from Gates Corp.'s poly chain GT carbon extended length belt (courtesy Gates Corp.).

WWW.RAVEGEARS.COM

RAVE GEARS

RAVE GEARS AND MACHINING

AS 9100 REGISTERED

ISO 9001:2008

AGMA

Rave Gears promises to deliver the highest quality gears & machined parts, on-time, at a fair price.

We specialize in Ground Tooth Spiral Bevel Gears & complex 9-axis machining.

Our key advantage: Streamlined processes using state-of-the-art engineering & production systems that result in cost savings & fast delivery.

Rave Gears is proud to be the best-equipped gear company in the USA.

Rave Gears has a strong team of talented engineering & production experts.

Current customers include Bell Helicopter, SpaceX, United Technologies, GE, Baker Hughes, Penske Racing.

Klingelnberg P65 Gear Analyzer

Klingelnberg G60 Gear Grinder

Mori Seki NT 5400

425 Strempel St. Seguin, TX USA 78155
(855) RAV GEAR | 855-728-4327 | 830-421-3295
sales@ravegears.com

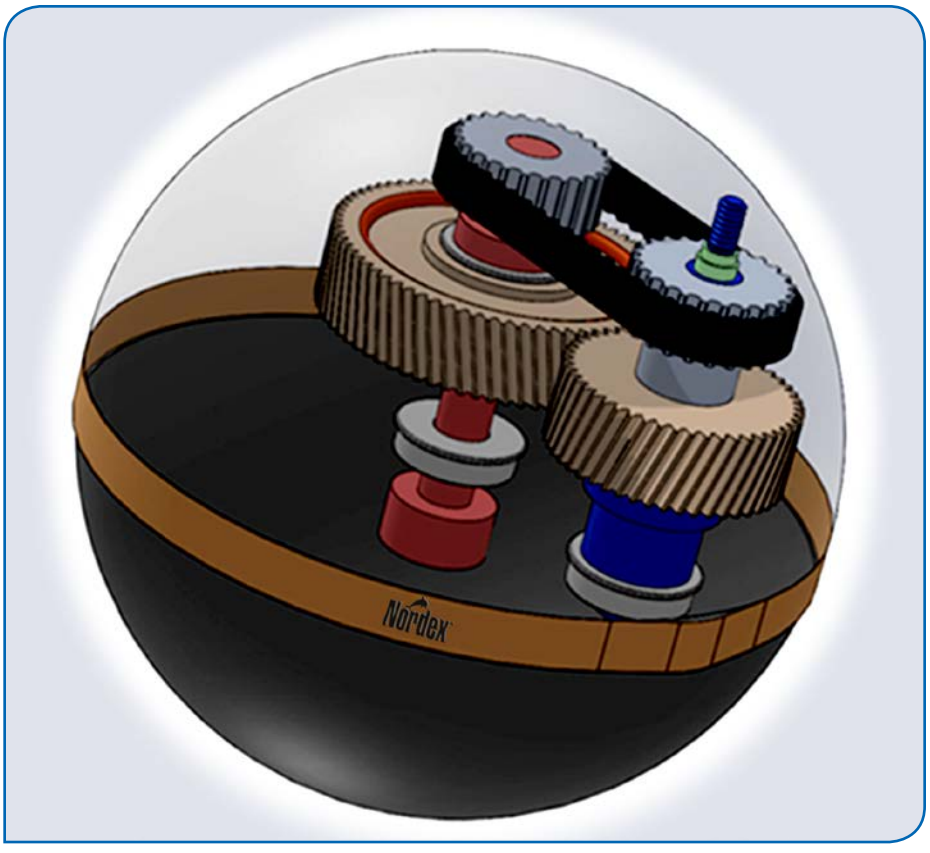


Figure 2 Illustration of synchronous belt assembly (courtesy Nordex Inc).

loads, plus chain length is easy to adjust by specifying the number of links required.

"The chain selection process is fairly straightforward. Key things to know are horsepower, RPM, intensity of shock load, temperature and exposure to potential corrosive conditions. A wide assortment of carbon steel chains, Lambda self-lube chains, Titan long life, Neptune corrosion-resistant, coated carbon steel, and stainless steel can be considered. The selection procedure quickly guides to the correct chain size."

We mentioned cleanroom, FDA-type applications where motion technology is required — steel or plastic? Both have their faults, as Nordex's Antonelli explains.

"For chain applications, the driving factor may be what temperature the device is in, or a requirement that no lubrication be used. Modern chains can be permanently coated/impregnated with a "dry" lubricant that inhibits wear and can eliminate the possibility of the lubricant contaminating the cleanroom. Rubber-style belts tend to flake and leave rubber shavings. There are new classes of "FDA" belts that reduce this flaking effect by a factor of 75%."

Taylor Jung, product line manager, synchronous drives, Industrial Power Transmission N.A for the Gates Corporation, concurs — followed by one critical difference. "Both belts and chains will produce some sort of contaminant during their operation. Chains have grease, oil, and metal particulates. Belts will shed material over time as well. Neither is a perfect solution. The primary differentiation between the two is in maintenance. Chains require routine lubrication and more frequent replacement. In wash-down environments, the potential for spread of grease and oil contamination is elevated and the maintenance requirements skyrocket. Polyurethane synchronous belts do not have any of these concerns and are a significant advantage in food handling environments."

Peer's Briere counters with the fact that "Roller chain in 304 material or a 600 stainless can now be manufactured with solid roller and solid bushing. Having no seam in any of the round parts is great for disinfecting

or cleaning without crevices for bacteria to grow. The solid bushing provides increased bearing area to spread and distribute the bearing load. Less stretch with solid bushing opposed to split bushing. Belts have a difficult time operating in wet caustic environments when wash-downs are required by FDA."

And at Tsubaki, clean-type, no-lube applications are still in play due to a patented steel chain. Say Hogan & Manta: "Our Lambda chain has an extended, longer wear life than our standard. Our chain is lube-free thanks to our oil-impregnated bushings, which not only helps minimize elongation, but also reduces downtime and maintenance operation cost. (The) chain is ideal for those applications where lubrication is impractical or impossible. Lambda has the same maximum allowable load as our standard roller chain. For applications with VOC limitations, chains with no lubrication, dry lubrication (Molykote), or plated pins can be considered."

Briere points out that, "If heat is involved, then stainless is a must to transmit power, convey or lift. If there is an extreme, abrasive element, chains can be hardened to survive in the tough environment. A great example would be cement and limestone (mills)."

Antonelli cautions that just any steel will not work in certain applications; homework must be done; choices must be made. Remember — this is a *process*.

"When talking about steel in general it is important to define which type of steel is being used," says Antonelli. "Standard-coated steel chain typically does not stand up well to certain environments such as sewage treatment plants and salt-water locations; stainless steel and alloy chains offer a possibility to overcome these issues. Also, when sludge or solids are a factor, belts would tend to clog or entrap the contaminating material, especially if a wide belt would be used. The open design of chains allow for the 'release' of such contaminates and make chains more forgiving than belts in those types of applications."

But when talking harsh environment, Jung reminds, "That depends on your definition (of harsh)," he says. "On one hand, if you have very high temperatures, chain is likely the best option. If caustic chemicals are present in the environment, then polyurethane synchronous belts will perform much better. It is a situation-dependent answer."

But if it's steel — or titanium — you require, Tsubaki, as do all the suppliers mentioned here, offers choices. "We typically suggest using stainless steel chain for any extremely harsh environment where extreme temperatures or corrosive chemicals are encountered," say Hogan & Manta. "Different grades are available, depending on the exact environment, including our 600 series, SS 304 stainless, NS 316 stainless steel, TI titanium series — and even PC plastic/steel combination chains.

"Stainless steel generally has one drawback: load capacity. Neptune Chain, which has a special triple coating "galvanic" type coating over our carbon steel chain, provides corrosion protection and has the same performance rating as our standard carbon chain."

We wondered: Are there any advantages of one (belts) over the other (chain) regarding use with the latest NEMA Premium motors? Or AC- vs. DC-drive type motor systems, for example? Are there any other performance differences between the two regarding motor-type compatibilities?

"Historically," says Nordex's Antonelli, "AC drives have tended to be more rugged and cost-efficient — especially in higher power applications — while

> *"Synchronous belt technology has more potential for innovation and its capabilities will grow faster than chain, leading to a perpetual, if ever narrowing market. The capability of carbon fiber tensile cords has not yet been fully explored."*
>
> **Taylor Jung,** Gates Corp.

For Related Articles Search
belt drives
at www.powertransmission.com

DC drives have tended to be the choice where high repeatability and positioning are concerned. This is especially true in reverse rotation and positioning applications. There are constant improvements in motors and control technology, so the line dividing AC and DC applications is tending to blur."

Hogan & Manta explain that "Chains are used in very precision-oriented robotics — often used for electronics or automation applications. Tsubaki offers bearing-bush chains which have a very exacting pitch tolerance; users can often set precision accuracy close to .005". (Our) bearing bush chain virtually eliminates initial stretch; with needle bearings placed between the pin and bushing, bearing bush chain offers excellent wear life without lubrication. Major dimensions of the chain and attachments are the same as our ASME/ANSI-standard, double-pitch conveyor chains; (it) works perfectly with standard, over-sized roller sprockets."

We then had a thought — is there ever a scenario in which both — steel and fabricated — are used in tandem?

"A systems integrator will opt for a belt/chain drive if it eliminates the need for another drive motor," says Bob Eisele, of Amacoil Inc. The traverse unit (see diagram) rides on a shaft that is belted to the main motor.

For Related Articles Search
chain
at www.powertransmission.com

If a separate drive motor was used to power the traverse, then electronic controls would be needed to synchronize the linear movement of the traverse with the rotational movement of the spool. Using the belt or chain to link the traverse driveshaft to the main shaft eliminates the need for another motor — saving time and money."

Similarly, are there applications where, at the end of the day, either one is equally acceptable in both performance and total cost? We started with Antonelli.

"Interesting question; my take on it would be any application where there are few controlling factor constraints. One trend we are noticing lately is the elimination of belts/chains/gears altogether by going to a direct-drive system. This is where the motor is driving the axis directly. This has cost, complexity and reliability benefits."

Jung offers that "While there are certain situations where both technologies have their advantages, the majority of drives would perform better and have a lower total cost of ownership with synchronous belts. This is because they do not require any regular main-

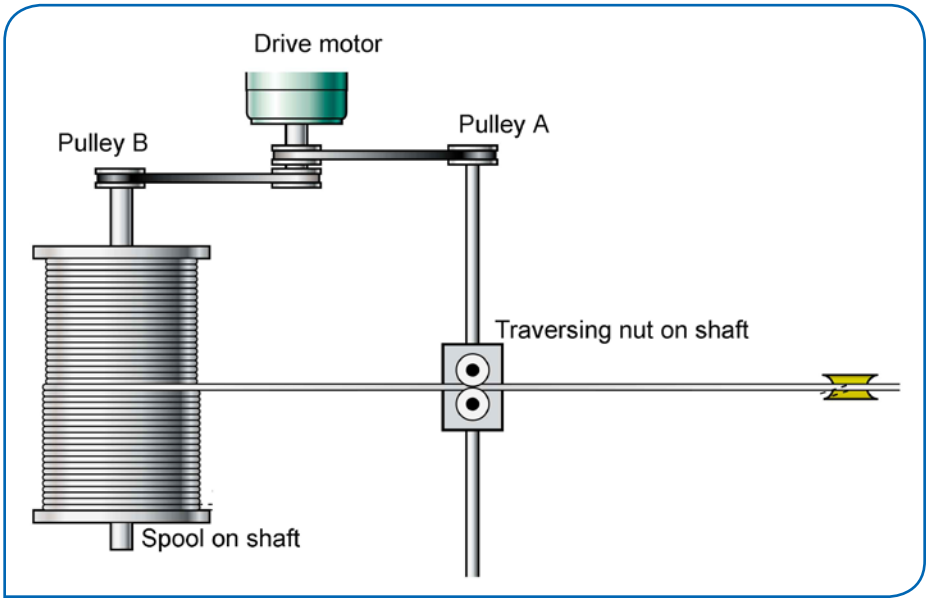


Figure 3 Note that traverse unit rides on a shaft that is belted to the main motor. If a separate drive motor was used to power the traverse, then electronic controls would be needed to synchronize the linear movement of the traverse with the rotational movement of the spool. Using the belt or chain to link the traverse drive shaft to the main shaft eliminates the need for another motor saving time and money (courtesy Amacoil).

"In today's world there are many factors that influence the decision on whether to use belts vs. chain drives. Many of these factors were not as important or not even considered just a few years ago."

Nick Antonelli, senior engineer, Nordex, Inc.

tenance and last longer than chain."

Another key consideration regarding belts/puller chains — width matters—for various reasons. Once upon a time, steel ruled in this regard. Things change.

"A wider belt may exhibit more frictional losses than a narrower belt," says Antonelli. "This effect is more pronounced if the belt in question tends to track to one side or the other. A wider belt typically tracks with more force than a narrower belt. A wider or multiple chain set-up may have an issue wear the individual chain strands or segments stretch at different rates and the different strands may not see the same loads."

Peer's Briere states that "Belts as friction drives are limited in ratio selection and to transmit higher horsepower increases the overall size due to the need for more surface/friction. Tooth belts simply do not have the ratio selection and are limited in center distance choices. Chains, on the other hand, are extremely flexible for machine design due to the ability to use almost any center distance and allow higher horsepower to be transmitted in smaller envelope dimensions."

Gates' Jung: "As a general statement, the best belt technology has been able to match chain widths for over 10 years. With either product, appropriate drive design is of key importance for long term performance. Under-design has its obvious resulting failures, but overdesign can result in premature failure as well, both of the belt and connected equipment." And Tsubaki's Hogan & Manta explain: "On a chain, increasing the width (multi-strand) will increase the chain's working load and the average tensile strength, while keeping sprocket diameters small. In general, for a given width, chain can often be narrower than belts for a given RPM and power requirement."

There's more to this part of the design process than we currently have space for — we haven't even touched upon things like software, bearings integration; ease-of-replacement; lifetimes…

Be we've left space for a bit of crystal ball gazing — e.g., belts, chains, glasses half-empty, half-full, etc.

"Chains have a future in the applications that I have mentioned in the questions above," says Jung. "Synchronous belt technology has more potential for innovation and its capabilities will grow faster than chain, leading to a perpetual, if ever narrowing market. The capability of carbon fiber tensile cords has not yet been fully explored. All of the surrounding belt components continue to be improved in order to fully utilize the strength of the carbon fiber cord. I don't feel that it is possible to identify the limits of the technology at this time."

But men of steel — fear not.

Says Peer Chain's Briere on whether there is a future for roller chain-type drive applications:

"There will always be a need for a positive drive." **PTE**

For more information:

The Gates Corporation
1551 Wewatta Streeet
Denver, CO 80202
Phone: (303) 744-5216
www.Gates.com

Nordex Inc.
426 Federal Road
Brookfield, CT 06804
Phone: (800) 243-0986
Fax: (203) 775-6552
info@nordex.com

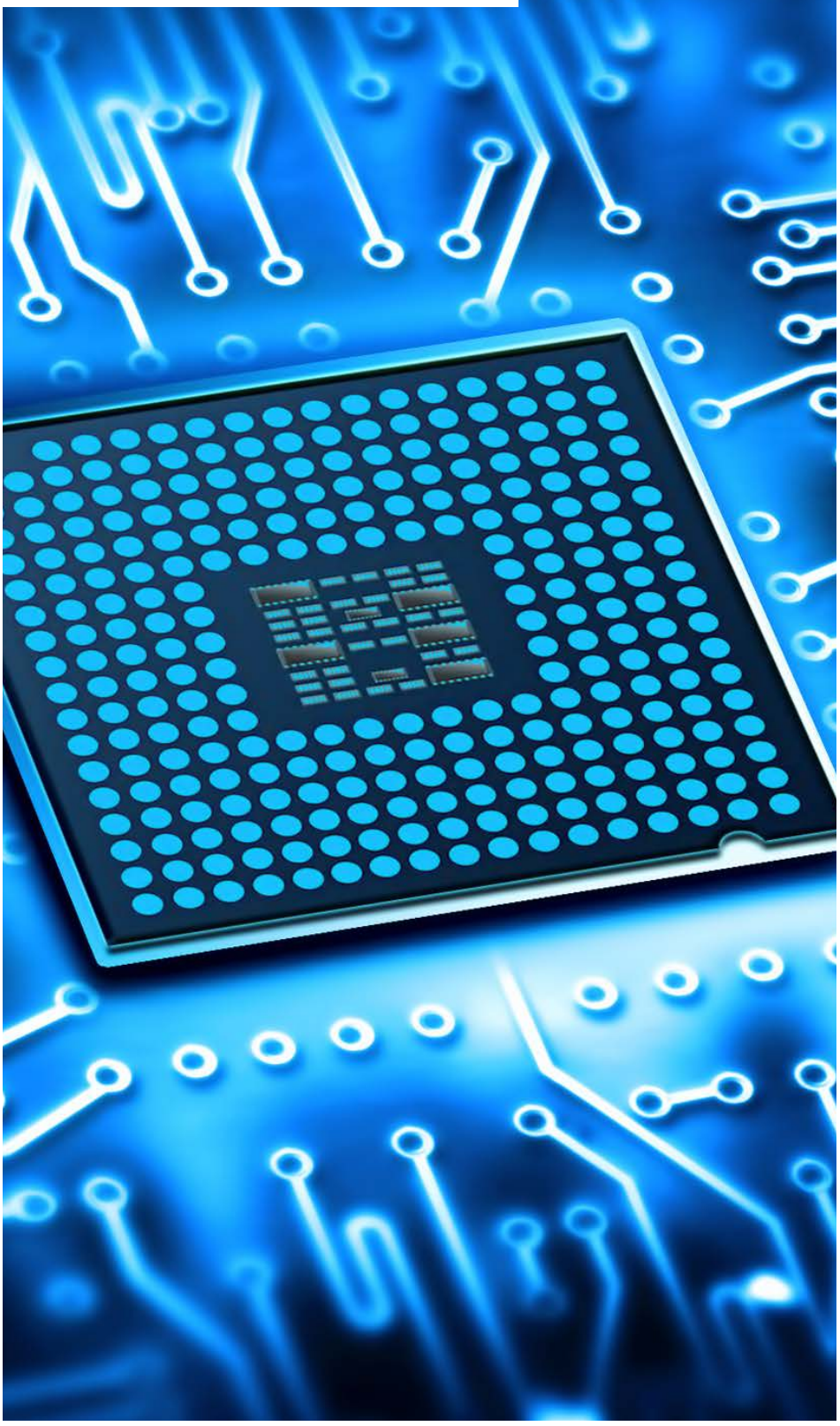
Peer Chain Company
Chuck Briere, National Sales Manager
2300 Norman Drive
Waukegan, IL 60085
cbriere@PEERchain.com

U.S. Tsubaki Power Transmission LLC
301 E. Marquardt Drive
Wheeling, IL 60090
Phone: (847) 459-9500; (800) 323-7790
Fax: (847) 459-9515
sales@ustsubaki.com

Steps Towards Revolution

The Industrial Internet is changing everything. Here's how to make sure you don't get left behind.

Alex Cannella, News Editor



The revolution goes by many names: machine-to-machine communication, smart manufacturing and the Industrial Internet, to name a few. In Europe, the prevailing term is Industry 4.0. In Germany, where that phrase was coined, the government is putting down €200 million to cultivate a lead in the industry. The McKinsey Global Institute estimates that its potential economic impact will be almost $4 trillion (or more) by 2025. Enthusiastic evangelists will tell you that the Industrial Internet is the most important advance in their industries that they've seen in their decades-long careers.

But, then again, this is the *Fourth Industrial Revolution* we're talking about. It has to be that important to live up to its name.

Make no mistake: the Industrial Internet is already here, and industrialists are adopting it in droves. An Infosys report recently found that 54 percent of businesses surveyed had already begun adopting the Industrial Internet, and of that 54 percent, a little over a third have fully implemented the new tech. Everybody from the Department of Defense to NASA are investigating how they can use the Industrial Internet, and if you aren't thinking about it yet, you should, too.

Brave New World

From the advent of steam power that brought about the first industrial revolution to the widespread adoption of computers in the '70s that characterized the third, the term has been reserved solely for leaps in efficiency so great that they rewrite the status quo and are utilized across the board, and the Industrial Internet looks like it deserves its place as the next big thing.

So what exactly is the fourth industrial revolution about? It encompasses multiple technologies that have al-

The First Name in Power Transmission

BALDOR • DODGE®

Baldor • Dodge® power transmission products offer reliable service and low maintenance to help reduce your total cost of ownership. Our innovative bearings, gearing and power transmission products have solved the toughest applications for over 130 years.

Our technical sales team can help you with the most challenging applications, and our worldwide distributor network ensures immediate delivery.

When it comes to PT solutions, Baldor • Dodge is the first name in power transmission.

baldor.com **479-646-4711**

- Unmatched Quality
- Superior Reliability
- Improved Uptime
- Quick Delivery

BALDOR®

A MEMBER OF THE ABB GROUP

Download a QR reader app and scan this code for more information.
http://esp.to/wo8AN5

ready been seeping into the workplace over the past decade. From cyber-physical systems to the advent of big data and the Internet of Things, all the different tech that constitutes the Industrial Internet contributes to a common cause: the interconnectivity and self-regulation of machinery and assembly lines. In a sense, Industry 4.0 and the Industrial Internet are an embracement of the direction the industrial world has already been moving in.

Machines will be able to monitor their own condition and give early warning for everything from when the oil gets low to when vital parts are on the verge of failing. By putting sensors in machinery and allowing them to constantly monitor themselves, we allow them to in turn give technicians more information more quickly than an entire team of dedicated professionals could ever hope to.

While there are some differences in application between the two (foremost being that Industry 4.0 is by Germans for Germans, while the Industrial Internet is more global and headed by American companies like GE and AT&T), they focus on most of the same emerging technologies and are used interchangeably by many people. From instantaneous communication between devices to self-regulating machines, their goal is the same as any other advance in the industry: reducing downtime and cutting costs.

"It's a whole paradigm shift," Jane Cahill, director of business development for Orbis America, said. "How people are working now and how they can use technology will really enhance the automation. It's very exciting."

Orbis is one of many businesses already offering both Industry 4.0 products and consulting services on the Industrial Internet. Their main product is the Orbis Multi-Process Suite, a modular product based on SAP technology. They've only just released the suite in America this year, but they've been implementing and evolving it in Germany since 2012. Orbis has seen numerous places where the Industrial Internet could be applied.

In particular, Cahill recounts an automotive industry producer from Alabama. When the company's machines went down, the maintenance staff often lost valuable time due to paperwork.

"The current team was taking maintenance calls, filling out the work order by hand, having somebody sign off on it by hand and then putting this data, which is simple data entry, into an Excel spreadsheet at the end of the shift so that they had some record of who worked on what machine, how long it took him or her and what parts they used," Cahill said. "All of that can be done and posted automatically in SAP now without a human being even having to do that if they use our software tools."

The bedrock for the Industrial Internet is the Internet of Things which, as its name might suggest, is a system where physical objects such as the varying robotic parts of an assembly line can communicate much like we people do on the Internet. The idea is that by allowing machines to transmit, pool and interpret data, we can make them more self-sufficient, reduce downtime and make the manufacturing process more streamlined.

One of the most literal examples of machine-to-machine communication is the use of RFID tags in assembly lines. Siemens and several other companies are using systems that utilize the tags on products to allow for a fully self-regulating production line. Under this system, a manufacturer could send a bottle or box through the production line with an attached RFID tag that contains specific instructions on how the product should be made. Everything from how to make the product to what label should go on the box is in the code. Each station on the assembly line reads the code for instructions, and at the end of the line, a final robot double-checks the product against the code to ensure it was made correctly.

Instead of programming a robot to do something a hundred times, then reprogramming it to do something else, this technology would allow businesses to pre-program how to make a dozen different products and make each at will, making small and varied orders more feasible and inventory management more precise. Alternatively, if you make a product with optional parts or multiple sizes, you could program the same machine to make each type.

Another of the Industrial Internet's main focuses is in the field of predictive maintenance. Right now, most maintenance is reactive. Technicians might check the oil level every now and then, but unless a machine grinds to a halt, no one's about to halt production to go digging through its guts

R+W®
A POPPE + POTTHOFF COMPANY

THE PERFECTIONIST

FOR DYNAMIC PRECISION APPLICATIONS:
OUR METAL BELLOWS COUPLING.

RW-AMERICA.COM

THE COUPLING.

and make sure a gear isn't fracturing or a brake pad hasn't worn down. At best, most companies do standard, periodic maintenance and have replacement parts on hand if something does go awry.

The Industrial Internet looks to revolutionize that entire process. Machines will be able to monitor their own condition and give early warning for everything from when the oil gets low to when vital parts are on the verge of failing. By putting sensors in machinery and allowing them to constantly monitor themselves, we allow them to in turn give technicians more information more quickly than an entire team of dedicated professionals could ever hope to. Maintenance would become more proactive and comprehensive than ever before.

Big Data rounds out many of the Industrial Internet's advances. Manufacturers can analyze their entire history of production and pick out patterns of everything from specific issues that could be improved upon to unexpected markets they're appealing to. For example, a car manufacturer could look across all its various car lines and identify which cars broke down the most consistently. From there, they could look at a list of all the reported ways those specific cars failed and see what's causing them to fail, be it a single part that wasn't quite up to snuff or a larger issue.

And so on and so forth, the manufacturer could continue digging deeper for as long as there's data to continue delving into, identifying points of improvement that would have been invisible before by computing sums of data so vast that they're impossible for an actual person to analyze.

America's Initiatives

Currently, the US is one of the leading nations when it comes to the Industrial Internet. Research and development is keeping pace with other leading countries in the field. Right now, there are two primary initiatives spearheading the effort: the Industrial Internet Consortium (IIC) and the Digital Manufacturing and Design Innovation Institute (DMDII).

The IIC is, according to their website, an "open membership, international not-for-profit consortium that is setting the architectural framework and direction for the Industrial Internet." They were founded in 2014 and are headed by AT&T, Cisco, GE, IBM and Intel. The IIC's main mission is to be a focal point for organizations, institutions and businesses interested in the Industrial Internet to get together and develop a common dialect and some standards. Different working groups in the IIC do everything from overseeing testbeds to spreading awareness about the Industrial Internet.

One of the IIC's contributing members, Belden, has been in the Industrial Internet game since before it had a dozen buzzword names and has had the unique opportunity to watch it develop from the start.

Everybody from the Department of Defense to NASA are investigating how they can use the Industrial Internet, and if you aren't thinking about it yet, you should, too.

"We see a number of things that are changing," Jeff Lund, senior director of product line management at Belden's Industrial IT Division said. "I think of the changes as occurring across two axes, horizontally within the control systems and vertically within the business.

"Horizontally within the control system, what we see with the Industrial Internet is that the use of industrial internet technologies is penetrating deeper and deeper into control systems, displacing legacy protocols and technologies and hardwired systems. In IIoT terms, you can think of us as connecting more and smaller things – moving from the connected factory (one big thing), to connected machines (more and smaller things), to connected controllers, and eventually to connected sensors and controllers. With each step the number of things grows by an order of magnitude or more.

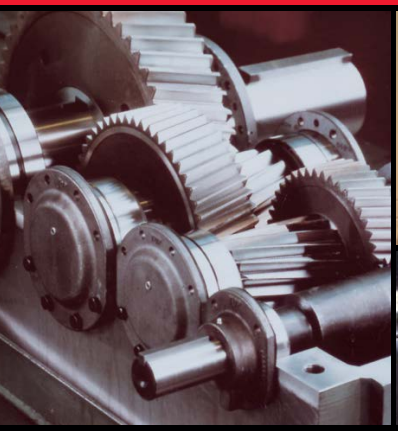
"Vertically within the business, what we see is a move toward more and more integration between business systems and the data flowing into and out of industrial control systems – what is often called IT/OT integration. Big data and analytics are also part of this trend. The overarching theme is that the data within control systems that has historically been used just for the operation of the system itself also contains a wealth of useful information that when made available to business systems can be used to drive a wide range of new efficiencies (better asset utilization, lower energy consumption, better supply chain management, etc.), along with other cost savings and revenue enhancements (predictive maintenance, manufacturing as a service, etc.)."

Amongst other efforts, Belden joined the IIC in July and has already involved itself in several of the IIC's working groups. Though their main focus is the security working group, they've involved themselves with numerous different sections of the IIC, from marketing to testbeds.

"The IIC has been great to work with," Lund said. "It is a very transparent and professional organization. Communication between IIC staff and between IIC members is very open and collaborative and the group is good at working together to get things done."

On the R&D side of things, the DMDII opened this May. With $70 million of backing from the government, the DMDII is working with dozens of partners to further study in almost every field of the Industrial Internet, from cybersecurity to developing Cloud services for CNC machining. In its first year, the institute has greenlit five projects and has another 15 under consideration.

The DMDII is part of a broader initiative being pushed by President Obama, the National Network for Manufacturing Innovation, that is focused on upgrading America's industrial sector through universal technology improvements such as the Industrial Internet. It stands along-







THE BRAND OEMs CAN TRUST WHEN SPECIFYING LUBRICANTS FOR THEIR MACHINERY

More and more original equipment manufacturers are specifying Lubriplate Lubricants for their machinery. Why? With 145 Years of Lubrication Experience, they know Lubriplate has the Quality Products and Services to meet their needs, the needs of their equipment and the needs of their customers.

A DEDICATED OEM DEPARTMENT

- OEM Technical Support - Dedicated to helping you select the best lubricant for a given application.
- Helps ensure equipment performance & service life.

A WIDE RANGE OF QUALITY PRODUCTS

- A Full Line of Advanced Technology Synthetic Lubricants.
- Traditional Petroleum-Based Oils and Greases.
- NSF H-1 Registered, NSF/ISO 21469 Certified Lubricants.

A WORLDWIDE DISTRIBUTION NETWORK

- A Strong Worldwide Distribution Network.
- Ensures availablity of correct service lubricants regardless of equipment location.

145 YEARS OF EXPERIENCE IN EVERY PRODUCT

"It's the Film" PREVENTS WEAR and CORROSION LUBRIPLATE SUPER-LUBRICATION

Lubriplate® Lubricants

Newark, NJ 07105 / Toledo, OH 43605 / www.lubriplate.com
Contact Ellen Girard, Lubriplate's OEM Marketing Analyst
Tel: 908-489-7355 / E-mail: egirard@lubriplate.com

Backed By: Lubriplate® ESP

Extra Services Package

Plant Surveys / Tech Support / Training
Color Coded Lube Charts & Machine Tags
Lubrication Software / Follow-Up Oil Analysis

side other institutes such as America Makes, LIFT, and Power America.

Future Steps

Despite the flocks of supporters behind the Industrial Internet, the movement's only a few years old and there are still serious issues that need addressing.

Foremost amongst them is the need for standardization. Much of the technology behind the Industrial Internet is heavily dependent on machines being able to communicate with each other, but two machines from different manufacturers that speak entirely different languages will not be able to work in tandem or transfer data. It is imperative that a framework of standards be introduced to ensure that as many different machines are compatible with each other as possible. Otherwise, the potential effects of Industry 4.0 will be severely blunted.

On the flip side, the more standardized the system becomes, the more data people will have access to. Machines could do more than just talk to each other, they could access data from other manufacturing plants. With set standards, datasets could potentially cross over between continents and companies alike.

After a basic framework comes network security. While those buzzwords may summon up images of code-slinging hackers coming to steal your data and make all your newly-interconnected machines go haywire, they actually aren't your main concern. According to an infographic put out by the IIC in October, hackers are actually in the minority when it comes to internet breaches. Only 20 percent of cyber "attacks" were intentional, brought about by a hacker or otherwise. Far more often, the problem could be attributed to malware (30.4 percent), system or software malfunction (38.4 percent) or user error (11.2 percent), and while hackers may be slowly becoming the boogeymen of the internet, the far more common issue is unintentional internet breaches.

Another primary issue will be education and employment. One of the major issues facing the industry today is the lack of educated workers entering the workforce, and the Industrial Internet will only exacerbate this problem. While the Industrial Internet will continue the trend of obsoleting repetitive, manual labor, it will be producing just as many new positions overseeing and maintaining machinery.

The only potential issue? The manual labor workers that are being displaced might not have the training to return to the industry and take up these new, more specialized jobs. A 2012 report from the U.S. Bureau of Labor found that only 18.7 percent of the manufacturing workforce has a bachelor's degree or higher. 45.6 percent haven't had any college experience. And while these numbers are an improvement from previous years and a bachelor's isn't necessarily required to perform the new jobs the Industrial Internet will create, much of the workforce will have to learn new skills to stay in the industry, which means that laying out a framework to get them the knowhow they need will be paramount.

Belden Inc. recommends a five-step approach to understanding and implementing the Industrial Internet of Things.

Willing, but not Quite Ready

Going back to Infosys's report, the Industrial Internet may be on the rise, but it still has a long way to go. Out of 433 companies surveyed in the US, Germany, China, the UK and France, 85 percent of companies are aware of Industry 4.0's potential, but only 15 percent have fully implemented strategies to take advantage of the Industrial Internet's capabilities. A further 39 percent have started taking steps towards implementing Industry 4.0 technologies, but they have yet to accomplish full integration.

A white paper published by Hannover Messe in January revealed similar numbers amongst German manufacturers: 84 percent of manufacturers "believe that Industry 4.0 will provide a new framework to human labor in production," but only 20 percent have a clear picture of what exactly that will entail. The DMDII has reported similar numbers, as well, reporting on their website that "81 percent of U.S. manufacturers acknowledged that digital manufacturing is a key element in their future competitiveness, but only 14 percent said they were ad-

equately equipped today with digital technologies and related expertise."

The results mirror Infosys's report. A lot of people want onboard the Industrial Internet bandwagon, but the number of manufacturers actually implementing it is far smaller.

However, this will probably all change in the near future. Infosys's report showed that while businesses may not be implementing the Industrial Internet right this moment, 48 percent of them are taking steps to ensure that they are fully implemented by 2020 and another 32 percent will be in the process of upgrading.

On Your Marks

And as more and more businesses line up to adopt the Industrial Internet, the vital question arises: how do you start your own Industrial Internet program?

And, more importantly, how do you keep from being overwhelmed in the process?

According to both Lund and Cahill, the main strategy is to pace yourself and not try to upgrade everything at once.

"When people think of everything that the IIoT might touch in their business over time it can be a bit overwhelming," Lund said. "Our view is that it isn't really feasible to say that before you can take your first step you must be able to foresee everything you might want to do over the life of your network - which could be decades. Rather, we think the key to building a solid building is to lay a strong foundation, the key to building out an Industrial Internet system is to build a strong network foundation so that your system can adapt to your changing business needs."

Belden's put together a five step process (Assess, Migrate/Update, Proper Design, Protection, and Monitor) that Lund recommends newcomers to the Industrial Internet follow.

Step one, assessing, is all about looking at the current state of your business and figuring out where you want to take it. Identifying where you are and where you want to go can often highlight the difficulties you need to overcome and make your approach much more focused.

"Before you start to build a new system, you need to understand what you already have, what its connectivity (wired/wireless, bandwidth, reliability) and environment requirements are, and what your near term goals are in terms of functionality and data exchange," Lund said. "The end result of the assessment stage should be an accurate 'map' of your network's infrastructure."

After that, the Migrate/Update step is about looking at any existing legacy systems you might already have and can repurpose or upgrade and investigating what kind of bandwidth and equipment requirements you're going to need to meet. The third step, Proper Design, is when Belden recommends taking a step back and making sure your program meets established best practices and standards (like, say, those standards the IIC is striving to create). Step four, Protection, is when you focus on system security (one of Belden's specialties) which, if you remember, has as much to do with making sure your system is accident-proof as keeping hackers out. Belden recommends a risk assessment as a good place to start. Step five, Monitoring, brings the process full circle.

"The last step is a feedback loop into the first," Lund said. "Technology is constantly changing. Security threats are changing. Business needs are changing. Customers need to monitor all of these things and make changes to their system accordingly...IIoT is a journey, not a destination. These are living systems that will evolve over time. The key thing, however, is that if customers follow the process we've outlined and think about things upfront, the infrastructure they deploy today will provide them the solid foundation they need to build on over time."

Cahill recommends starting small. She believes that the best place to start is with a specific application or problem the company's having, something small and, more importantly, measurable.

"What we're really advising people to do is not to try to take on the whole beast at one time, if you will," Cahill said. "Once that return on investment is realized, it's very easy to then grow it and expand it. The product itself is very scalable, and companies then run with it, thinking of all different other applications that they'd be really excited to be able to use it in."

One case study that Orbis supported involved a company's shipping system.

"The company was spending a tremendous amount of money on trucks that were sitting idly by waiting to be loaded at the loading dock," Cahill said. "And the management did not really have a handle on their day-to-day operations. They knew what needed to be loaded and what needed to go out, but they did not have clear vision down to the minute in real-time, as to the progress that was being made with the loading of these trucks."

The solution was for Orbis to develop a program that would follow the packing process and show it all on one screen. The manager would be able to see when trucks were supposed to leave, what needed to go on them, and how far into the loading process the truck was.

"In that instance, [with] a very simple pilot program, that manager was able to determine 'do I let the truck go partially filled? Do I accrue the added overtime...or do I know right then at that second if I need to throw more resources at the problem?'" Cahill said. "That kind of real-time information is essential for people to be able make resource-efficient decisions."

Inevitably, each company will implement the Industrial Internet in its own way based on its situation, but there are numerous options on how to go about upgrading. The important thing to remember is that not only should you jump on the Industrial Internet bandwagon, you also can. **PTE**

For more information:

Belden
Phone: (800) 125-2261
www.belden.com

Orbis USA
Phone: (703) 734-6494
www.orbisusa.com/en/

2015 *PTE* Buyers Guide

About This Directory

The 2015 *Power Transmission Engineering* Buyers Guide was compiled to provide you with a handy resource containing the contact information for significant suppliers of power transmission components.

Bold Listings throughout the Buyers Guide indicate that a company has an advertisement in this issue of *Power Transmission Engineering*.

How to Get Listed in the Buyers Guide

Although every effort has been made to ensure that this Buyers Guide is as comprehensive, complete and accurate as possible, some companies may have been inadvertently omitted. If you'd like to add your company to the directory, we welcome you. Please visit *www.powertransmission.com/getlisted.php* to fill out a short form with your company information and Buyers Guide categories. These listings will appear online at *www.powertransmission.com*, and those listed online will automatically appear in next year's printed Buyers Guide.

Handy Online Resources

The *Power Transmission Engineering* Buyers Guide – The listings printed here are just the basics. Visit our online buyers guide for the most comprehensive directory of suppliers of gears, bearings, motors, clutches, couplings, gear drives and other mechanical power transmission components, broken down into sub-category by type of product manufactured:

www.powertransmission.com/directory/

The Gear Industry Buyers Guide – If you manufacture gears or need information on suppliers of machine tools, tooling and services for gear manufacturers, please visit the buyers guide on *Gear Technology's* website:

www.geartechnology.com/dir/

ACCESSORIES

ABL Products Incorporated
www.ablproducts.com

AGI Automation Components
www.agi-automation.com

AISCO Industrial Couplings
www.aiscoinc.com

ASI Technologies Inc.
www.asidrives.com

AST Bearings
www.astbearings.com

Accent Bearings Co. Inc.
www.accentbearing.com

Ace World Companies
www.aceworldcompanies.com

Acorn Industrial Services
www.acorn-ind.co.uk

Advanced Test & Automation Inc.
www.advancedta.com

Aerotech Inc.
www.aerotech.com

Akron Gear and Engineering
www.akrongear.com

AmTech International
www.amtechinternational.com

Amacoil, Inc.
www.amacoil.com

American Collars & Couplings Inc.
www.americancollars.com

American Plastics Depot
www.americanplasticsdepot.com

Ameridrives Power Transmission
www.ameridrivespowertransmission.com

Ametric / American Metric Corporation
www.ametric.com

Applied Dynamics
www.applied-dynamics.com

Area Distributors Inc.
www.areadist.com

Artec Machine Systems
www.artec-machine.com

Ascent Precision Gear Corporation
www.ascentgear.com

Ashutosh Power TransBelts Limited
www.aptbelts.com

Atlanta Drive Systems Inc.
www.atlantadrives.com

Axu s.r.l.
www.axu.it/en

B&B Manufacturing, Inc.
www.bbman.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

BRECOflex CO., L.L.C.
www.brecoflex.com

Baldor Electric Company
SEE OUR AD P25
5711 R.S. BOREHAM, JR. ST.
P.O. BOX 2400
FORT SMITH AR 72901
Phone: (479) 646-4711
Fax: (479) 648-5792
www.baldor.com

Bearing Service Company
www.bearing-service.com

Bearings Limited
www.bearingslimited.com

Beijing THC Limited
www.beijingthc.com

Belcon Engineers P. Ltd.
www.belconengineers.com

BellowsTech, LLC
www.bellowstech.com

Bevel Gears India Pvt. Ltd.
www.jamalgears.co.in

Bibby Transmissions
www.bibbytransmissions.co.uk

Bishop-Wisecarver Corp.
www.bwc.com

Brevini Power Transmission - Canada
www.brevini.com

Brewer Machine & Gear Co.
www.brewertensioner.com

CENTA Corp.
www.centa.info

CMS Vibration Solutions Ltd.
www.cmsantivibration.co.uk

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Challenge Power Transmission (Aust) Pty Ltd
www.challengept.com

Challenge Power Transmission PLC
www.challengept.com

Collars and Couplings Inc.
www.collarsandcouplings.com

ComInTec Srl
www.comintec.it

Conroll Corporation
www.conroll.com

Core Supply LLC
www.coresupplyllc.com

Cortec Corporation
www.cortecvci.com

Cross + Morse
www.crossmorse.com

Currie Enterprises
www.currieenterprises.com

Custom Machine & Tool Co. Inc.
www.cmtco.com

Cyclo-Index
www.cycloindex.com

Daido Corporation of America
www.daidocorp.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Darbar Belting
www.darbarbelting.co.in

Datasyst Engineering & Testing Services, Inc.
www.datasysttest.com

Daubert Cromwell LLC
www.daubertcromwell.com

Davall Gears Ltd.
www.davall.com

Del-Tron Precision Inc.
www.deltron.com

Designatronics, Inc.
SEE OUR AD P7
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com

Distag QCS
www.distag.com

Drive Components LLC
www.drivecomponentsllc.com

Drive Systems Technology Inc.
www.gear-doc.com

Duff Norton Sales South Pacific
www.dnsales.com.au

Electro Steel Engineering Company
www.indiamart.com/tyginc

Emerson Industrial Automation - Drives & Motor
www.emersonindustrial.com

Equipment Concepts
www.equipment-concepts.com

Filter Pumper / Hydraulic Problems, Inc.
www.filterpumper.com

Flux Drive Inc.
www.fluxdrive.com

Framo Morat Inc. SEE OUR AD P45
9440 SAN MATEO BLVD NE
SUITE L
ALBUQUERQUE NM 87113
Phone: (505) 359-2949
Fax: (505) 881-2070
sales@framo-morat.com
www.framo-morat.com

GMB Associates
www.gmbassociates.co.uk

Gajra Gears Pvt. Ltd.
www.gajra.com

Gates Corporation
www.gates.com

Gayatri Gear Industries
www.gayatrigear.com

Gear Master Inc.
www.gearmaster.us

Gleason K2 Plastics
www.k2plasticsinc.com

HBM
www.hbm.com

Hangzhou Xingda Machinery Co. Ltd.
www.xdmade.com

Hayes Manufacturing Inc.
www.hayescouplings.com

Heidenhain Corporation
www.heidenhain.com

Henan Contrust Gear Transmission Co., Ltd.
www.contrust-gear.com

Hi-Grade Inc.
www.higradeinc.com

Houghton International Inc.
www.houghtonintl.com

IBT, Inc
www.ibtinc.com

IDA Motion Inc.
www.idamotion.com

IDC Select
www.IDCselect.com

ISC Companies
www.isccompanies.com

ITW Heartland
www.itwheartland.com

Industrial Jig & Fixture
www.industrialjigandfixture.com

Industrial Pulley & Machine Co, Inc.
www.industrialpulley.com

Intech Corporation
www.intechpower.com

Intellidrives, Inc
www.intellidrives.com

J.W. Winco Inc. SEE OUR AD P2
2815 S. CALHOUN ROAD
NEW BERLIN WI 53151
Phone: (800) 877-8351
sales@jwwinco.com
www.jwwinco.com

JVL Industri Elektronik A/S
www.jvl.dk

Jason Industrial Inc.
www.jasonindustrial.com

K+S Services
www.k-and-s.com

KBK Antriebstechnik Gmbh
www.kbk-antriebstechnik.de

KTR Corporation SEE OUR ADS P21,39,47
122 ANCHOR ROAD
MICHIGAN CITY INDIANA 46360
Phone: (219) 872-9100
Fax: (219) 872-9150
ktr-us@ktr.com
www.ktr.com

Kamar Industries
www.kamarindustries.com

Kinefac Corporation
www.kinefac.com

Kluber Lubrication North America L.P.
www.kluber.com

Kollmorgen Div. of Danaher
www.kollmorgen.com

LM76 Linear Motion Bearings
www.LM76.com

Lafert North America SEE OUR AD P13
5620 KENNEDY RD.
MISSISSAUGA ON L4Z 2A9
CANADA
Phone: (905) 629-1939 or
toll free (800) 661-6413
Fax: (905) 629-2852
sales@lafertna.com
www.lafertna.com

Lovejoy, Inc.
www.lovejoy-inc.com

MGT - Magnetic Gearing & Turbine Corp.
www.mgt.com.au

MMB Bearing Co. Inc.
www.mmbbearings.com

MROSupply
www.mrosupply.com

MT Tool & Manufacturing
www.ourmachinist.com

Magnum Manufacturing
www.magnum-mfg.com

Magtrol, Inc.
www.magtrol.com

Maguire Technologies
www.maguiretech.com

Martin Sprocket & Gear
www.martinsprocket.com

Maurey Manufacturing Corporation
www.maurey.com

Maxcess
www.maxcessintl.com

Micronor Inc.
www.micronor.com

Miki Pulley US SEE OUR AD P20
13200 6TH AVENUE NORTH
PLYMOUTH MN 55441
Phone: (800) 533-1731
Fax: (763) 546-8260
sales@mikipulley-us.com
www.mikipulley-us.com

Ming Chang Traffic Parts Mfg.
www.mccchain.com.tw

Mini-Broach Machine Company
www.minibroach.com Minsk Gear Works
www.mgw.by

Motion Industries
www.motionindustries.com

Moventas Ltd.
www.moventas.com

NDE Power Transmissions
www.ndepower.com

Netshape Technologies, Inc.
www.netshapetech.com

New England Belting Company
www.newenglandbelting.com

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

North American Clutch & Driveline
www.naclutch.com

Norwin Electronics Limited
www.norwin.co.uk

Novotec Argentina SRL
www.novotecargentina.com

Onvio LLC
www.onviollc.com

Orttech
www.orttech.com

PI (Physik Instrumente) L.P. Piezo Actuator Nano
www.pi-usa.us

PIC Design
www.pic-design.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Paul's Transmission Shenzhen Co.,ltd
www.chinatransmission.com.cn

Peer Bearing Company
www.peerbearing.com

Pix Transmissions Limited
www.pixtrans.com

Plastock - Putnam Precision Molding, Inc.
www.plastockonline.com

Popular Mechanical Works
www.popularmechworks.com

Potomac Electric
www.potomacelectric.com/

Power Transmission Engineers
www.ptegears.com

Pulley Manufacturers International Inc.
www.pulleys.com

Pylon Gears (Pty) Ltd
www.gearing.co.za

QA1 Precision Products SEE OUR AD P82
21730 HANOVER AVE
LAKEVILLE MN 55044
Phone: (800) 721-7761
Fax: (952) 985-5679
sales@qa1.net
www.qa1.net/industrial

RGW Sales Canada
www.rgwsalescanada.com

Regal Power Transmission Solutions
www.regalpts.com

René Baer AG
www.renebaerag.ch

Resistoflex Private Limited
www.resistoflex.in

Ringball Corporation
www.ringball.com

Ringspann Corporation
www.ringspanncorp.com

Ritbearing Corp.
www.ritbearing.com

Rockwell Automation
www.rockwellautomation.com

Romax Technology Limited
www.romaxtech.com

Rotor Clip Company, Inc.
www.rotorclip.com

Rowland Co., The
www.rowland2.com

Rubena a.s.
www.rubena.cz

Ruland Manufacturing Co., Inc.
www.ruland.com

SEW-Eurodrive
1295 OLD SPARTANBURG HWY.
P.O. BOX 518
LYMAN SC 29635
Phone: (864) 439-7537
Fax: (864) 439-7830
www.seweurodrive.com
SEE OUR AD INSIDE BACK COVER

SKF USA Inc.
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com
SEE OUR AD P3

SKG Enterprises
www.skgsons.com

SPN Schwaben Praezision
www.spn-hopf.de

Schenck Trebel Corporation
www.schenck-usa.com

Sipco-MLS
www.sipco-mls.com

Smart Manufacturing Technology - SMT
www.smartmt.com

Sprockets Australia Pty. Ltd.
www.sprocketsoz.com.au

Stearns Division / Rexnord Industries Inc.
www.rexnord.com/stearns

Steelmans Broaches Pvt Ltd
www.steelmans.com

Steinmeyer Inc.
www.steinmeyer.com

Sterling Instrument
www.sdp-si.com

Stock Drive Products
www.sdp-si.com

Stoffel Polygon Systems, Inc.
www.stoffelpolygon.com

Sumitomo Machinery Corp. of America
www.smcyclo.com

T.E.A. Machine Components
www.teausa.net

TSS Rotterdam B.V.
www.tssr.nl

Taiwan Precision Gear Corp.
www.tpg-tw.com

Tampa Armature Works- TAW
www.tawinc.com

Tapeswitch Corporation
www.tapeswitch.com

Team Industries
www.team-ind.com

Technico
www.technico.com

Tef - Cap Industries
www.TefCap.com

Thomson Div. of Danaher
www.thomsonlinear.com

Tien Yi Gear Works Co.,Ltd
www.tienyigear.com.tw

Torque Transmission
www.torquetrans.com

Transply Inc.
www.transply.com

Tristate Bearing & Supply Co. Inc.
www.tristatebearing.com

Trojon Gear Inc.
www.trojon-gear.com

Tsubaki of Canada Limited
www.tsubaki.ca

VCST LP
www.vcst.be

VL Motion Systems Inc.
www.vlmotion.com

Vision Qualitry Components, Inc
www.visionqci.com

WD Bearing America
www.wd-bearing.com

WMH Transmissions Ltd
www.wmh-trans.co.uk

Warner Linear
www.warnerlinear.com

Whittet-Higgins Company
www.whittet-higgins.com

Zerelli Technologies Inc
www.zerelli.com

ACTUATORS

AGI Automation Components
www.agi-automation.com

Acme Gear Co.
www.acmegear.com

Acorn Industrial Services
www.acorn-ind.co.uk

Aerotech Inc.
www.aerotech.com

Agnee Transmissions (I) Pvt Ltd
www.agneetransmissions.com

Agro Engineers
www.agroengineers.com

Akgears, LLC
www.akgears.com

Amacoil, Inc.
www.amacoil.com

Ametric / American Metric Corporation
www.ametric.com

Anaheim Automation, Inc.
www.anaheimautomation.com

Atlanta Drive Systems Inc.
www.atlantadrives.com

Avion Technologies Inc.
www.avion-tech.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Bearings and Industrial Supply Co., Inc.
www.bearingsnow.com

Beaver Aerospace and Defense Inc.
www.beaver-online.com

Befared
www.befared.com.pl

BellowsTech, LLC
www.bellowstech.com

Bevel Gears India Pvt. Ltd.
www.jamalgears.co.in

Bharat Gears Ltd.
www.bharatgears.com

Bishop-Wisecarver Corp.
www.bwc.com

Buehler Motor, Inc.
www.buehlermotor.com

Central Gear & Machine
www.cgmatlanta.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Control Switches International Inc
www.controlswitches.com

Core Supply LLC
www.coresupplyllc.com

Curtis Machine Co. Inc.
www.curtismachine.com

Custom Sensors & Technologies
www.cstsensors.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Del-Tron Precision Inc.
www.deltron.com

Designatronics, Inc.
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com
SEE OUR AD P7

Discovery Technology International, Inc.
www.discovtech.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

Duff Norton Australia
www.duffnorton.com.au

Duff Norton Sales South Pacific
www.dnsales.com.au

Dunkermotoren USA Inc.
www.dunkermotor.com

Dynamic Structures and Materials, LIc
www.dynamic-structures.com

Emerson Industrial Automation - Drives & Motor
www.emersonindustrial.com

Exlar Actuation Solutions
www.exlar.com

FMC Engineering
www.fmcengineering.com

Festo Corporation
www.festo.com/usa

Foshan Xingguang Transmission Machinery Co. Ltd.
www.xg-cd.cn

Framo Morat Inc.
9440 SAN MATEO BLVD NE
SUITE L
ALBUQUERQUE NM 87113
Phone: (505) 359-2949
Fax: (505) 881-2070
sales@framo-morat.com
www.framo-morat.com
SEE OUR AD P45

Gil Equipamentos Industriais Ltda.
www.gil.com.br

Gleason K2 Plastics
www.k2plasticsinc.com

H2W Technologies
www.h2wtech.com

Hallmark Industries Inc.
www.hallmarkind.com

Houston Pump and Gear
www.houstonpumpandgear.com

IAI America, Inc.
www.intelligentactuator.com

IBT, Inc
www.ibtinc.com

ISC Companies
www.isccompanies.com

ITW Heartland
www.itwheartland.com

Industrial Clutch Parts Ltd.
www.icpltd.co.uk

Intellidrives, Inc
www.intellidrives.com

K+S Services
www.k-and-s.com

Kamar Industries
www.kamarindustries.com

Kollmorgen Div. of Danaher
www.kollmorgen.com

LYC North America Inc
www.lycbearings.com

Lab Threads & Gear Works, Inc.
www.labthreads.com

MROSupply
www.mrosupply.com

Mavilor Motors, S.a.
www.mavilor.es

Maxcess
www.maxcessintl.com

Midwest Motion Products
www.midwestmotion.com

Motion Industries
www.motionindustries.com

NGT Specialty Valves
www.ngtvalves.com

Niebuhr Gears
www.niebuhr.dk

Ningbo Zhongyi Hydraulic Motor Co. Ltd.
www.zihyd.com

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

North American Clutch & Driveline
www.naclutch.com

Norwin Electronics Limited
www.norwin.co.uk

Novotec Argentina SRL
www.novotecargentina.com

PI (Physik Instrumente) L.P. Piezo Actuator Nano
www.pi-usa.us

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Parker Hannifin SSD Drives Div.
www.parker.com/ssdusa

Performance Gear Systems, Inc.
www.performance-gear.com

Popular Mechanical Works
www.popularmechworks.com

Portescap
www.portescap.com

Potomac Electric
www.potomacelectric.com/

Precipart
www.precipart.com

Precision Screw Thread
www.precisionscrewthread.com

RGW Sales Canada
www.rgwsalescanada.com

Rex Engineering Corp.
www.rex-engineering.com

Ringball Corporation
www.ringball.com

Rockwell Automation
www.rockwellautomation.com

Rowland Co., The
www.rowland2.com

S.M. Shah & Company
www.hydraulicvanepump.com

SEW-Eurodrive SEE OUR AD INSIDE BACK COVER
1295 OLD SPARTANBURG HWY.
P.O. BOX 518
LYMAN SC 29635
Phone: (864) 439-7537
Fax: (864) 439-7830
www.seweurodrive.com

SKF USA Inc. SEE OUR AD P3
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com

SPN Schwaben Praezision
www.spn-hopf.de

Sallex Machine Tools
www.sallex.com

Schaeffler Group USA, Inc SEE OUR AD BACK COVER
308 SPRINGHILL FARM ROAD
FORT MILL SC 29715
Phone: (803) 548-8500
Fax: (803) 548-8599
info.us@schaeffler.com
www.schaeffler.us

Schneider Electric Motion USA
www.motion.schneider-electric.com

Serapid Inc.
www.serapid.us

Servometer
www.servometer.com

Sesame Motor Corp. SEE OUR AD P43
599, SEC. 1, HEMU RD.
SHENGANG TAICHUNG 42953
TAIWAN
Phone: +(886) 4-2561-0011
Fax: +(886) 4-2562-7766
info@sesamemotor.com.tw
www.sesamemotor.com.tw

Sipco-MLS
www.sipco-mls.com

Steinmeyer Inc.
www.steinmeyer.com

Sterling Instrument
www.sdp-si.com

Stoffel Polygon Systems, Inc.
www.stoffelpolygon.com

T.E.A. Machine Components
www.teausa.net

Taiwan United Gear Co., Ltd.
www.tugear.com.tw

Technico
www.technico.com

Thomson Div. of Danaher
www.thomsonlinear.com

Tolomatic, Inc.
www.tolomatic.com

VL Motion Systems Inc.
www.vlmotion.com

WEG
www.weg.net

Warner Linear
www.warnerlinear.com

Wittenstein
www.wittenstein-us.com

ADJUSTABLE SPEED DRIVES

AISCO Industrial Couplings
www.aiscoinc.com

ASI Technologies Inc.
www.asidrives.com

Ace World Companies
www.aceworldcompanies.com

Acme Gear Co.
www.acmegear.com

Acorn Industrial Services
www.acorn-ind.co.uk

Aerotech Inc.
www.aerotech.com

Agro Engineers
www.agroengineers.com

Akgears, LLC
www.akgears.com

Allied Motion
www.alliedmotion.com

Amacoil, Inc.
www.amacoil.com

Ametric / American Metric Corporation
www.ametric.com

Andantex USA Inc.
www.andantex.com

Applied Dynamics
www.applied-dynamics.com

Area Distributors Inc.
www.areadist.com

Atlanta Gear Works, Inc
www.gearboxrepair.com

Automation Direct SEE OUR AD INSIDE FRONT COVER
3505 HUTCHINSON ROAD
CUMMING GA 30040
Phone: (800) 633-0405
Fax: (770) 889-7876
sales@automationdirect.com
www.automationdirect.com

B&B Manufacturing, Inc.
www.bbman.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Baldor Electric Company SEE OUR AD P25
5711 R.S. BOREHAM, JR. ST.
P.O. BOX 2400
FORT SMITH AR 72901
Phone: (479) 646-4711
Fax: (479) 648-5792
www.baldor.com

Bearing Service Company
www.bearing-service.com

Beaver Aerospace and Defense Inc.
www.beaver-online.com

Bevel Gears India Pvt. Ltd.
www.jamalgears.co.in

Bison Gear and Engineering Corp.
www.bisongear.com

Bonfiglioli Riduttori S.p.A.
www.bonfiglioli.com

Bonfiglioli USA
www.BonfiglioliUSA.com

Boston Gear
www.bostongear.com

Brevini Power Transmission - Canada
www.brevini.com

Brevini USA
www.breviniusa.com/index.asp

Brewer Machine & Gear Co.
www.brewertensioner.com

Buehler Motor, Inc.
www.buehlermotor.com

Carlisle Power Transmission
www.carlislebelts.com

Carlyle Johnson Machine Co. LLC, The
www.cjmco.com

Central Gear & Machine
www.cgmatlanta.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Challenge Power Transmission PLC
www.challengept.com

Cleveland Gear Co.
www.clevelandgear.com

Conroll Corporation
www.conroll.com

Custom Motors Inc.
www.custommotorsmn.com

Cutes Corporation
www.cutes.com.tw

Dalton Bearing Service, Inc.
www.daltonbearing.com

Davall Gears Ltd.
www.davall.com

Duff Norton Australia
www.duffnorton.com.au

Dunkermotoren USA Inc.
www.dunkermotor.com

Dynex/Rivett Inc.
www.dynexhydraulics.com

Electronic Machine Parts
www.empregister.com

Emerson Industrial Automation - Drives & Motor
www.emersonindustrial.com

Essential Power Transmission Pvt. Ltd.
www.esenpro.com

FMC Engineering
www.fmcengineering.com

Fairchild Industrial Products Co.
www.specontransmission.com

Festo Corporation
www.festo.com/usa

Flux Drive Inc.
www.fluxdrive.com

Framo Morat Inc. SEE OUR AD P45
9440 SAN MATEO BLVD NE
SUITE L
ALBUQUERQUE NM 87113
Phone: (505) 359-2949
Fax: (505) 881-2070
sales@framo-morat.com
www.framo-morat.com

GMB Associates
www.gmbassociates.co.uk

Gayatri Gear Industries
www.gayatrigear.com

Gil Equipamentos Industriais Ltda.
www.gil.com.br

HPB Motion Control Co. Ltd.
www.hpb-industry.com

Hoffmann Technics AG
www.hoffmann-tech.ch

Houston Pump and Gear
www.houstonpumpandgear.com

IBT, Inc
www.ibtinc.com

ISC Companies
www.isccompanies.com

Intellidrives, Inc
www.intellidrives.com

K+S Services
www.k-and-s.com

KB Controls
www.kb-controls.com

Lafert North America SEE OUR AD P13
5620 KENNEDY RD.
MISSISSAUGA ON L4Z 2A9
CANADA
Phone: (905) 629-1939 or
toll free (800) 661-6413
Fax: (905) 629-2852
sales@lafertna.com
www.lafertna.com

Leeson Electric
www.leeson.com

Marshall Wolf Automation Inc.
www.wolfautomation.com

Maurey Manufacturing Corporation
www.maurey.com

Mavilor Motors, S.a.
www.mavilor.es

Miki Pulley US SEE OUR AD P20
13200 6TH AVENUE NORTH
PLYMOUTH MN 55441
Phone: (800) 533-1731
Fax: (763) 546-8260
sales@mikipulley-us.com
www.mikipulley-us.com

Mitsubishi Electric Automation, Inc.
us.mitsubishielectric.com/fa/en

Motion Industries
www.motionindustries.com

NAC Drive Systems
www.nacdrivesystems.com

New Power Electric (USA) LLC
www.usa-newpower.com

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

Norwin Electronics Limited
www.norwin.co.uk

Novotec Argentina SRL
www.novotecargentina.com

PI (Physik Instrumente) L.P. Piezo Actuator Nano
www.pi-usa.us

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Parker Hannifin - SSD Drives Div.
www.ssddrives.com

Performance Gear Systems, Inc.
www.performance-gear.com

Phytron, Inc.
www.phytron.com

Potomac Electric
www.potomacelectric.com/

Precipart
www.precipart.com

René Baer AG
www.renebaerag.ch

Rockwell Automation
www.rockwellautomation.com

S.M. Shah & Company
www.hydraulicvanepump.com

SEW-Eurodrive SEE OUR AD INSIDE BACK COVER
1295 OLD SPARTANBURG HWY.
P.O. BOX 518
LYMAN SC 29635
Phone: (864) 439-7537
Fax: (864) 439-7830
www.seweurodrive.com

Sallex Machine Tools
www.sallex.com

Schneider Electric Motion USA
motion.schneider-electric.com

Serapid Inc.
www.serapid.us

Siemens Energy & Automation
www.sea.siemens.com

Siemens Industry, Inc.
www.usa.siemens.com/industry/us/en

Siti Spa Riduttori
www.sitiriduttori.it

Sprockets Australia Pty. Ltd.
www.sprocketsoz.com.au

Sterling Instrument
www.sdp-si.com

Stober Drives, Inc.
www.stober.com

Stoffel Polygon Systems, Inc.
www.stoffelpolygon.com

Suzhou Asia Pacific Metal Co., Ltd.
www.szapmc.com

TB Wood's
www.tbwoods.com

TVT America, Inc.
www.tvtamerica.com

Taiwan Precision Gear Corp.
www.tpg-tw.com

Tampa Armature Works- TAW
www.tawinc.com

Team Industries
www.team-ind.com

Teco Westinghouse
www.tecowestinghouse.com

Thomson Div. of Danaher
www.thomsonlinear.com

Tolomatic, Inc.
www.tolomatic.com

Transply Inc.
www.transply.com

Tristate Bearing & Supply Co. Inc.
www.tristatebearing.com

VL Motion Systems Inc.
www.vlmotion.com

Var-Spe Variatori Oleodinamici
www.varspe.com

Vision International
www.engimech.com

WEG
www.weg.net

WorldWide Electric
www.worldwideelectric.net

Zero-Max
www.zero-max.com

BEARINGS

AST Bearings
www.astbearings.com

Accent Bearings Co. Inc.
www.accentbearing.com

Acorn Industrial Services
www.acorn-ind.co.uk

Aerotech Inc.
www.aerotech.com

American Plastics Depot
www.americanplasticsdepot.com

American Swiss Products Co., Inc.
www.americanswiss.com

Ametric / American Metric Corporation
www.ametric.com

Applied Dynamics
www.applied-dynamics.com

Area Distributors Inc.
www.areadist.com

Auburn Bearing & Manufacturing
www.auburnbearing.com

B&B Manufacturing, Inc.
www.bbman.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Baker Bearing Company
www.bakerbearing.com

Baldor Electric Company SEE OUR AD P25
5711 R.S. BOREHAM, JR. ST.
P.O. BOX 2400
FORT SMITH AR 72901
Phone: (479) 646-4711
Fax: (479) 648-5792
www.baldor.com

Barrel Service Company
www.barrelservice.com

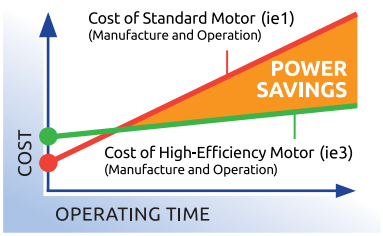
Bearing Service Company
www.bearing-service.com

Go really green.

Get faster ROI and long-term savings with Brother's ie3 Premium Efficiency Gearmotors.

- Increased efficiency throughout the speed range translates into huge, long-term energy savings*
- Less noise, less heat, less mechanical stress*
- Reduce costly downtime with virtually maintenance-free gearmotors that are sealed for life
- Enhanced durability with long-lasting, e-coat paint and H1 Food Grade Grease

*When compared to Brother IE1 gearmotor.



ie3 PREMIUM EFFICIENCY SERIES

Brother Earth

Take advantage of Brother's ie3 Premium Efficiency Gearmotors…and turn your competition green with envy.

Stay Compliant in 2016

Let our team help keep you ahead of upcoming IE3 efficiency government regulation requirements.

brother
at your side

BrotherGearmotors.com

Bearings Limited
www.bearingslimited.com

Beijing THC Limited
www.beijingthc.com

Bishop-Wisecarver Corp.
www.bwc.com

Bison Gear and Engineering Corp.
www.bisongear.com

Boca Bearing Company
www.bocabearings.com

Boston Gear
www.bostongear.com

Brewer Machine & Gear Co.
www.brewertensioner.com

C&U Americas, LLC
www.cubearing.com

Carlisle Power Transmission
www.carlislebelts.com

Central Gear & Machine
www.cgmatlanta.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Challenge Power Transmission (Aust) Pty Ltd
www.challengept.com

Challenge Power Transmission PLC
www.challengept.com

Climax Metal Products Company
www.climaxmetal.com

Core Supply LLC
www.coresupplyllc.com

Craft Bearing Company, Inc.
www.craftbearing.com

Cross + Morse
www.crossmorse.com

Daemar Inc.
www.daemar.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Del-Tron Precision Inc.
www.deltron.com

Designatronics, Inc. SEE OUR AD P7
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com

Discovery Technology International, Inc.
www.discovtech.com

Drive Components LLC
www.drivecomponentsllc.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

EDT Corp
www.edtcorp.com

Electro Static Technology
www.est-aegis.com

F.K. Bearings
www.fkrodends.com

FK Bearing Corp.
www.fk-bearing.com

FMC Engineering
www.fmcengineering.com

Formsprag Clutch
www.formsprag.com

Frantz Mfg. Co.
www.frantz-mfg.com

Fusion Babbitting Co, Inc
www.fusionbabbitting.com

GMB Associates
www.gmbassociates.co.uk

GMN Bearing USA, Ltd.
www.gmnbt.com

Gil Equipamentos Industriais Ltda.
www.gil.com.br

Hangzhou Xingda Machinery Co. Ltd.
www.xdmade.com

Houston Pump and Gear
www.houstonpumpandgear.com

IBT, Inc
www.ibtinc.com

IDA Motion Inc.
www.idamotion.com

IDC Select
www.IDCselect.com

IMO USA Corp.
www.imo.us

ISC Companies
www.isccompanies.com

Industrial Friction Materials Ltd.
www.industrialfriction.com

Intellidrives, Inc
www.intellidrives.com

Kaydon Corporation Bearings Division
www.kaydonbearings.com

Kilian Manufacturing Corp.
www.kilianbearings.com

Kinefac Corporation
www.kinefac.com

LM76 Linear Motion Bearings
www.LM76.com

LYC North America Inc
www.lycbearings.com

Luoyang SBI Special Bearing Co. Ltd.
www.sbibearings.com

MMB Bearing Co. Inc.
www.mmbbearings.com

MT Tool & Manufacturing
www.ourmachinist.com

Maguire Technologies
www.maguiretech.com

Martin Sprocket & Gear
www.martinsprocket.com

Micronor Inc.
www.micronor.com

Mineral Circles Bearings
www.mcb.ae

Modern Linear Inc.
www.modernlinear.com

Motion Industries
www.motionindustries.com

Moventas Ltd.
www.moventas.com

NSK Americas SEE OUR AD P38
4200 GOSS ROAD
ANN ARBOR MI 48105
Phone: (800) NSK-9930
Fax: (734) 913-7503
info@nsk-corp.com
www.nskamericas.com

Nachi America Inc.
www.nachiamerica.com

Napoleon Engineering Services
www.nesbearings.com

Netshape Technologies, Inc.
www.netshapetech.com

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

Novotec Argentina SRL
www.novotecargentina.com

Ondrives Ltd
www.ondrives.com

Onvio LLC
www.onviollc.com

PIC Design
www.pic-design.com

PSL of America
www.pslofamerica.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Pacamor Kubar Bearings (pkb)
www.pacamor.com

Pacific Bearing
www.pacific-bearing.com

Pacific Industries
www.pacificindustries.com

Paul's Transmission Shenzhen Co.,ltd
www.chinatransmission.com.cn

Peer Bearing Company
www.peerbearing.com

Pioneer Motor Bearing Co.
www.pioneer1.com

Pulley Manufacturers International Inc.
www.pulleys.com

Pylon Gears (Pty) Ltd
www.gearing.co.za

QA1 Precision Products SEE OUR AD P82
21730 HANOVER AVE
LAKEVILLE MN 55044
Phone: (800) 721-7761
Fax: (952) 985-5679
sales@qa1.net
www.qa1.net/industrial

Quality Bearings & Components
www.qbcbearings.com

RBI Bearing Inc.
www.rbibearing.com

RGW Sales Canada
www.rgwsalescanada.com

Regal Power Transmission Solutions
www.regalpts.com

René Baer AG
www.renebaerag.ch

Ringball Corporation
www.ringball.com

Ritbearing Corp.
www.ritbearing.com

Rockwell Automation
www.rockwellautomation.com

Rubena a.s.
www.rubena.cz

SKF USA Inc. SEE OUR AD P3
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com

SKG Enterprises
www.skgsons.com

SYX Bearing
www.syxbearing.com

Schaeffler Group USA, Inc SEE OUR AD BACK COVER
308 SPRINGHILL FARM ROAD
FORT MILL SC 29715
Phone: (803) 548-8500
Fax: (803) 548-8599
info.us@schaeffler.com
www.schaeffler.us

Sprockets Australia Pty. Ltd.
www.sprocketsoz.com.au

Sterling Instrument
www.sdp-si.com

Stock Drive Products
www.sdp-si.com

Supreme Gear Co.
www.supremegear.com

T.E.A. Machine Components
www.teausa.net

TB Wood's
www.tbwoods.com

TSS Rotterdam B.V.
www.tssr.nl

Tef - Cap Industries
www.TefCap.com

Thomson Div. of Danaher
www.thomsonlinear.com

Top Machinery & Equipment (Zhengzhou) Ltd
www.top-rol.com

Torque Transmission
www.torquetrans.com

Transply Inc.
www.transply.com

Tristate Bearing & Supply Co. Inc.
www.tristatebearing.com

Trojon Gear Inc.
www.trojon-gear.com

Tsubaki of Canada Limited
www.tsubaki.ca

VL Motion Systems Inc.
www.vlmotion.com

Vision Qualitry Components, Inc
www.visionqci.com

WD Bearing America
www.wd-bearing.com

WMH Transmissions Ltd
www.wmh-trans.co.uk

Yogi Bearings
www.yogibearings.com

BELTING & BELT DRIVES

ABL Products Incorporated
www.ablproducts.com

Accent Bearings Co. Inc.
www.accentbearing.com

Ace World Companies
www.aceworldcompanies.com

Acedes Gear Tools
www.acedes.co.uk

Acorn Industrial Services
www.acorn-ind.co.uk

Agro Engineers
www.agroengineers.com

Akron Gear and Engineering
www.akrongear.com

Amacoil, Inc.
www.amacoil.com

American Gear & Engineering
www.americangear.net

American Gear, Inc.
www.americangearinc.com

American Plastics Depot
www.americanplasticsdepot.com

Ametric / American Metric Corporation
www.ametric.com

Applied Dynamics
www.applied-dynamics.com

Area Distributors Inc.
www.areadist.com

Ascent Precision Gear Corporation
www.ascentgear.com

Ashutosh Power TransBelts Limited
www.aptbelts.com

Avion Technologies Inc.
www.avion-tech.com

B&B Manufacturing, Inc.
www.bbman.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

BRECOflex CO., L.L.C.
www.brecoflex.com

Baldor Electric Company SEE OUR AD P25
5711 R.S. BOREHAM, JR. ST.
P.O. BOX 2400
FORT SMITH AR 72901
Phone: (479) 646-4711
Fax: (479) 648-5792
www.baldor.com

Bearing Service Company
www.bearing-service.com

Beijing THC Limited
www.beijingthc.com

Belcon Engineers P. Ltd.
www.belconengineers.com

Bervina
www.bervina.com

Bishop-Wisecarver Corp.
www.bwc.com

Boca Bearing Company
www.bocabearings.com

Bowman Hollis Mfg
www.bowmanhollis.com

Brevini Power Transmission - Canada
www.brevini.com

Brewer Machine & Gear Co.
www.brewertensioner.com

Butler Gear
www.butlergear.com

Capstan Atlantic
www.capstanatlantic.com

Carlisle Power Transmission
www.carlislebelts.com

Carnes-Miller Gear Co., Inc.
www.cmgear.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Challenge Power Transmission (Aust) Pty Ltd
www.challengept.com

Challenge Power Transmission PLC
www.challengept.com

Cincinnati Gearing Systems SEE OUR AD P2
5757 MARIEMONT AVE.
CINCINNATI OH 45227
Phone: (513) 527-8600
Fax: (513) 527-8635
gearsales@cst-c.com
www.cincinnatigearingsystems.com

Clark Gear Works, Inc.
www.clarkgearworks.com

Clarke Engineering Inc. (Clarke Gear Co.) SEE OUR AD P54
8058 LANKERSHIM BLVD.
NORTH HOLLYWOOD, CA 91605
Phone: (818) 768-0690
Fax: (818) 767-5577
clarkegear@earthlink.net
www.clarkegear.com

ComInTec Srl
www.comintec.it

Commercial Gear & Sprocket Co. Inc.
www.commercialgear.com

Cone Drive
www.conedrive.com

Conroll Corporation
www.conroll.com

ContiTech North America
www.contitech.us

Core Supply LLC
www.coresupplyllc.com

Cross + Morse
www.crossmorse.com

Custom Machine & Tool Co. Inc.
www.cmtco.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Darbar Belting
www.darbarbelting.co.in

Davall Gears Ltd.
www.davall.com

Dee Bee Enterprise
www.deebee-enterprise.com

Del-Tron Precision Inc.
www.deltron.com

Delta Gear Corp.
www.delta-gear.com

Desch Canada Ltd.
www.desch.on.ca

Designatronics, Inc. SEE OUR AD P7
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com

Dimatic Die & Tool Co.
www.dimatic.com

Distag QCS
www.distag.com

Drive Components LLC
www.drivecomponentsllc.com

Dura-Belt
www.durabelt.com

Dymco, Co
www.dymco.co.jp

Electro Steel Engineering Company
www.indiamart.com/tyginc

Excel Gear, Inc. SEE OUR AD P14
11865 MAIN STREET
ROSCOE IL 61073
Phone: 815-623-3414
Fax: 815-623-3314
chinn@excelgear.com
www.excelgear.com

First Gear Engineering & Technology
www.first-gear.com

Flux Drive Inc.
www.fluxdrive.com

Forest City Gear Co. SEE OUR AD P5
11715 MAIN STREET
ROSCOE IL 61073
Phone: (815) 623-2168
Fax: (815) 623-6620
www.fcgear.com

Framo Morat Inc. SEE OUR AD P45
9440 SAN MATEO BLVD NE
SUITE L
ALBUQUERQUE NM 87113
Phone: (505) 359-2949
Fax: (505) 881-2070
sales@framo-morat.com
www.framo-morat.com

GMB Associates
www.gmbassociates.co.uk

Gates Corporation
www.gates.com

Gayatri Gear Industries
www.gayatrigear.com

Gear Design & Service Pty. Ltd.
www.geardesign.com.au

George Lane & Sons Ltd
www.georgelane.co.uk

Gil Equipamentos Industriais Ltda.
www.gil.com.br

Hangzhou Xingda Machinery Co. Ltd.
www.xdmade.com

Hayes Manufacturing Inc.
www.hayescouplings.com

IBT, Inc
www.ibtinc.com

IDC Select
www.IDCselect.com

ISC Companies
www.isccompanies.com

Industrial Jig & Fixture
www.industrialjigandfixture.com

Industrial Pulley & Machine Co, Inc.
www.industrialpulley.com

Intech Corporation
www.intechpower.com

Jason Industrial Inc.
www.jasonindustrial.com

Kamar Industries
www.kamarindustries.com

Kapsyn Manufacturing Company
www.kapsyn.com

Leeson Electric
www.leeson.com

Lovejoy, Inc.
www.lovejoy-inc.com

MES INC
www.mesinc.net

MGT - Magnetic Gearing & Turbine Corp.
www.mgt.com.au

MT Tool & Manufacturing
www.ourmachinist.com

Maguire Technologies
www.maguiretech.com

Martin Sprocket & Gear
www.martinsprocket.com

Maurey Manufacturing Corporation
www.maurey.com

Midwest Brake
www.midwestbrake.com

Miki Pulley US SEE OUR AD P20
13200 6TH AVENUE NORTH
PLYMOUTH MN 55441
Phone: (800) 533-1731
Fax: (763) 546-8260
sales@mikipulley-us.com
www.mikipulley-us.com

Ming Chang Traffic Parts Mfg.
www.mccchain.com.tw

Motion Industries
www.motionindustries.com

Nav Auxichem Pvt. Ltd
www.perfectbelting.com

Neelkanth Beltings
www.neelkanthbeltings.com

Netshape Technologies, Inc.
www.netshapetech.com

New England Belting Company
www.newenglandbelting.com

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

North American Clutch & Driveline
www.naclutch.com

Novotec Argentina SRL
www.novotecargentina.com

Ongears - Ondrives Export Gears
www.ongears.co.uk

Ontario Gear and Spline
www.ontariogearandspline.com

Onvio LLC
www.onviollc.com

PIC Design
www.pic-design.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Paul's Transmission Shenzhen Co.,ltd
www.chinatransmission.com.cn

Pix Transmissions Limited
www.pixtrans.com

Plastock - Putnam Precision Molding, Inc.
www.plastockonline.com

Popular Mechanical Works
www.popularmechworks.com

Premier Udyog
www.premierudyog.org

Pulley Manufacturers International Inc.
www.pulleys.com

Pylon Gears (Pty) Ltd
www.gearing.co.za

Regal Power Transmission Solutions
www.regalpts.com

René Baer AG
www.renebaerag.ch

Ringball Corporation
www.ringball.com

Rockwell Automation
www.rockwellautomation.com

Rowland Co., The
www.rowland2.com

Rubena a.s.
www.rubena.cz

Rush Gears Inc.
www.rushgears.com

SKF USA Inc. SEE OUR AD P3
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com

SKG Enterprises
www.skgsons.com

Sallex Machine Tools
www.sallex.com

Schafer Industries SEE OUR AD P49
4701 NIMTZ PARKWAY
SOUTH BEND IN 46628-6151
Phone: (574) 234-4116
Fax: (574) 234-4115
pshah@schafergear.com
www.schafergear.com

Sprockets Australia Pty. Ltd.
www.sprocketsoz.com.au

Stock Drive Products
www.sdp-si.com

Supreme Gear Co.
www.supremegear.com

T.E.A. Machine Components
www.teausa.net

TB Wood's
www.tbwoods.com

TSS Rotterdam B.V.
www.tssr.nl

TVT America, Inc.
www.tvtamerica.com

Taiwan United Gear Co., Ltd.
www.tugear.com.tw

Tampa Armature Works- TAW
www.tawinc.com

Team Industries
www.team-ind.com

Tolomatic, Inc.
www.tolomatic.com

Top Machinery & Equipment (Zhengzhou) Ltd
www.top-rol.com

Torque Transmission
www.torquetrans.com

Transply Inc.
www.transply.com

Tristate Bearing & Supply Co. Inc.
www.tristatebearing.com

Trojon Gear Inc.
www.trojon-gear.com

Tsubaki of Canada Limited
www.tsubaki.ca

VL Motion Systems Inc.
www.vlmotion.com

Vision International
www.engimech.com

Vision Qualitry Components, Inc
www.visionqci.com

Volta Belting
www.voltabelting.com

WMH Transmissions Ltd
www.wmh-trans.co.uk

Yogi Bearings
www.yogibearings.com

Zeon Belts Pvt. Ltd.
www.zeonbelts.com

BRAKES

Acionac Indústria e Comércio Ltda
www.acionac.com.br

Andantex USA Inc.
www.andantex.com

Applied Dynamics
www.applied-dynamics.com

Applied Power Solutions
www.apscorp.com

Area Distributors Inc.
www.areadist.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Beaver Aerospace and Defense Inc.
www.beaver-online.com

Bison Gear and Engineering Corp.
www.bisongear.com

Brevini Power Transmission - Canada
www.brevini.com

Carlyle Johnson Machine Co. LLC, The
www.cjmco.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Coremo Ocmea S.r.l.
www.coremo.ocmea.it

Cryotron Magnadrives
www.cmdindia.com

Currie Enterprises
www.currieenterprises.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Dellner Brakes AB
www.dellner-brakes.com

Desch Canada Ltd.
www.desch.on.ca

Designatronics, Inc. SEE OUR AD P7
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com

Dings Company
www.dingsbrakes.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

Dunkermotoren USA Inc.
www.dunkermotor.com

Electromatic Engineers Pvt. Ltd
www.clutchesbrakes.com

Emco Dynatorq Pvt. Ltd.
www.emco-dynatorq.in

Force Control Indutries
www.forcecontrol.com

GKN Land Systems
www.gknlandsystems.com

GMB Associates
www.gmbassociates.co.uk

Gummi USA
www.gummiusa.com

Hilliard Corp., The
www.hilliardcorp.com

Hoffmann Technics AG
www.hoffmann-tech.ch

IBT, Inc
www.ibtinc.com

ISC Companies
www. isccompanies.com

Industrial Clutch Parts Ltd.
www.icpltd.co.uk

Industrial Friction Materials Ltd.
www.industrialfriction.com

Inertia Dynamics, Inc.
www.idicb.com

JVL Industri Elektronik A/S
www.jvl.dk

Johnson Industries Ltd.
www.brakes.ca

KTR Corporation SEE OUR ADS P21,39,47
122 ANCHOR ROAD
MICHIGAN CITY INDIANA 46360
Phone: (219) 872-9100
Fax: (219) 872-9150
ktr-us@ktr.com
www.ktr.com

Klam America
www.electricbrakesystems.com

Lafert North America SEE OUR AD P13
5620 KENNEDY RD.
MISSISSAUGA ON L4Z 2A9
CANADA
Phone: (905) 629-1939 or (800) 661-6413
Fax: (905) 629-2852
sales@lafertna.com
www.lafertna.com

MES INC
www.mesinc.net

MICO, Incorporated
www.mico.com

Mach III Clutch Inc.
www.machiii.com

Magnetic Technologies Ltd
www.magnetictech.com

Magtrol, Inc.
www.magtrol.com

Marshall Wolf Automation Inc.
www.wolfautomation.com

Matrix International
www.matrix-international.com

Mayr Corporation
www.mayrcorp.com

Midwest Brake
www.midwestbrake.com

Midwest Motion Products
www.midwestmotion.com

Miki Pulley US SEE OUR AD P20
13200 6TH AVENUE NORTH
PLYMOUTH MN 55441
Phone: (800) 533-1731
Fax: (763) 546-8260
sales@mikipulley-us.com
www.mikipulley-us.com

Motion Industries
www.motionindustries.com

New Torque, Inc.
www.clutches-brakes.com

Ningbo Zhongyi Hydraulic Motor Co. Ltd.
www.zihyd.com

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

North American Clutch & Driveline
www.naclutch.com

Novotec Argentina SRL
www.novotecargentina.com

Onvio LLC
www.onviollc.com

Orttech
www.orttech.com

PIC Design
www.pic-design.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Palmer Johnson Power Systems
www.pjpower.com

Pethe Engineering Private Limited
www.pethe.in

Power Transmission Engineers
www.ptegears.com

Precipart
www.precipart.com

Ringspann Corporation
www.ringspanncorp.com

Rockwell Automation
www.rockwellautomation.com

Rowland Co., The
www.rowland2.com

Sprockets Australia Pty. Ltd.
www.sprocketsoz.com.au

Stearns Division / Rexnord Industries Inc.
www.rexnord.com/stearns

Stephenson Gobin Transmissions
www.stephensongobin.com

Sterling Instrument
www.sdp-si.com

Stock Drive Products
www.sdp-si.com

Stoffel Polygon Systems, Inc.
www.stoffelpolygon.com

TB Wood's
www.tbwoods.com

Taiwan Precision Gear Corp.
www.tpg-tw.com

Team Industries
www.team-ind.com

Thomson Div. of Danaher
www.thomsonlinear.com

Tolomatic, Inc.
www.tolomatic.com

Transply Inc.
www.transply.com

Twiflex Limited
www.twiflex.com

VL Motion Systems Inc.
www.vlmotion.com

Vortex Engineering Works
www.vortex-clutch.com WPT Power Corporation
www.wptpower.com

CHAIN & CHAIN DRIVES

ABL Products Incorporated www.ablproducts.com

Accent Bearings Co. Inc.
www.accentbearing.com

Accurate Gear and Machine, Inc.
www.accurategear.com

Acedes Gear Tools
www.acedes.co.uk

Acorn Industrial Services
www.acorn-ind.co.uk

Agro Engineers
www.agroengineers.com

Akron Gear and Engineering
www.akrongear.com

American Plastics Depot
www.americanplasticsdepot.com

Ametric / American Metric Corporation
www.ametric.com

Area Distributors Inc.
www.areadist.com

Ascent Precision Gear Corporation
www.ascentgear.com

B & R Machine and Gear Corp. SEE OUR AD P9
4809 U.S. HWY. 45
SHARON TN 38255
Phone: (731) 456-2636 or (800) 238-0651
Fax: (731) 456-3073
inquiry@brgear.com
www.brgear.com

B&B Manufacturing, Inc.
www.bbman.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Bearing Service Company
www.bearing-service.com

Bearings Limited
www.bearingslimited.com

Beijing THC Limited
www.beijingthc.com

Bishop-Wisecarver Corp.
www.bwc.com

Bowman Hollis Mfg
www.bowmanhollis.com

Brevini Power Transmission - Canada
www.brevini.com

Brewer Machine & Gear Co.
www.brewertensioner.com

C-B Gear & Machine
www.cbgear.com

Central Gear & Machine
www.cgmatlanta.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Challenge Power Transmission (Aust) Pty Ltd
www.challengept.com

Challenge Power Transmission PLC
www.challengept.com

Cloyes Gear & Products Inc.
www.cloyes.com

Cogmatic
www.cogmatic.com

Commercial Gear & Sprocket Co. Inc.
www.commercialgear.com

Core Supply LLC
www.coresupplyllc.com

Cross + Morse
www.crossmorse.com

Daido Corporation of America
www.daidocorp.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Darbar Belting
www.darbarbelting.co.in

Davall Gears Ltd.
www.davall.com

Desch Canada Ltd.
www.desch.on.ca

Designatronics, Inc. SEE OUR AD P7
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com

Diamond Chain Company SEE OUR AD P17
402 KENTUCKY AVENUE
INDIANAPOLIS IN 46225
Phone: (800) 872-4246
Fax: (317) 613-2243
sales@diamondchain.com
www.diamondchain.com

Distag QCS
www.distag.com

Electro Steel Engineering Company
www.indiamart.com/tyginc

First Gear Engineering & Technology
www.first-gear.com

Framo Morat Inc. SEE OUR AD P45
9440 SAN MATEO BLVD NE
SUITE L
ALBUQUERQUE NM 87113
Phone: (505) 359-2949
Fax: (505) 881-2070
sales@framo-morat.com
www.framo-morat.com

GMB Associates
www.gmbassociates.co.uk

Gates Corporation
www.gates.com

Gayatri Gear Industries
www.gayatrigear.com

Gear Master Inc.
www.gearmaster.us

Hangzhou Xingda Machinery Co. Ltd.
www.xdmade.com

Henan Contrust Gear Transmission Co., Ltd.
www.contrust-gear.com

IBT, Inc
www.ibtinc.com

IDC Select
www.IDCselect.com

ISC Companies
www.isccompanies.com

Kamar Industries
www.kamarindustries.com

MGT - Magnetic Gearing & Turbine Corp.
www.mgt.com.au

MT Tool & Manufacturing
www.ourmachinist.com

Martin Sprocket & Gear
www.martinsprocket.com

Melfast
www.melfast.com

Ming Chang Traffic Parts Mfg.
www.mccchain.com.tw

Motion Industries
www.motionindustries.com

Moventas Ltd.
www.moventas.com

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

North American Clutch & Driveline
www.naclutch.com

Nu-Teck Couplings Pvt. Ltd
www.nuteckcouplings.com

PIC Design
www.pic-design.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Pacific Industries
www.pacificindustries.com

Paul's Transmission Shenzhen Co.,ltd
www.chinatransmission.com.cn

Peer Bearing Company
www.peerbearing.com

Performance Gear Systems, Inc.
www.performance-gear.com

Pix Transmissions Limited
www.pixtrans.com

Plastock - Putnam Precision Molding, Inc.
www.plastockonline.com

Pulley Manufacturers International Inc.
www.pulleys.com

RBI Bearing Inc.
www.rbibearing.com

Regal Power Transmission Solutions
www.regalpts.com

René Baer AG
www.renebaerag.ch

Renold Jeffrey
www.renoldjeffrey.com

Ringball Corporation
www.ringball.com

Rockwell Automation
www.rockwellautomation.com

Rowland Co., The
www.rowland2.com

SKF USA Inc. SEE OUR AD P3
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com

SKG Enterprises
www.skgsons.com

ST Gear & Machine LLC
www.stgearandmachine.com

Serapid Inc.
www.serapid.us

Sprockets Australia Pty. Ltd.
www.sprocketsoz.com.au

Stock Drive Products
www.sdp-si.com

Taiwan United Gear Co., Ltd.
www.tugear.com.tw

Team Industries
www.team-ind.com

Torque Transmission
www.torquetrans.com

Transply Inc.
www.transply.com

Tristate Bearing & Supply Co. Inc.
www.tristatebearing.com

Trojon Gear Inc.
www.trojon-gear.com

Tsubaki of Canada Limited
www.tsubaki.ca

VL Motion Systems Inc.
www.vlmotion.com

WMH Transmissions Ltd
www.wmh-trans.co.uk

Yogi Bearings
www.yogibearings.com

CLUTCHES

AISCO Industrial Couplings
www.aiscoinc.com

Accent Bearings Co. Inc.
www.accentbearing.com

Acionac Indústria e Comércio Ltda
www.acionac.com.br

Andantex USA Inc.
www.andantex.com

Applied Power Solutions
www.apscorp.com

Area Distributors Inc.
www.areadist.com

Ascent Precision Gear Corporation
www.ascentgear.com

Bearing Service Company
www.bearing-service.com

Bibby Transmissions
www.bibbytransmissions.co.uk

Boston Gear
www.bostongear.com

CENTA Corp.
www.centa.info

Cabat Inc.
www.cabatinc.com

Carlyle Johnson Machine Co. LLC, The
www.cjmco.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

ComInTec Srl
www.comintec.it

Commercial Gear & Sprocket Co. Inc.
www.commercialgear.com

Coremo Ocmea S.r.l.
www.coremo.ocmea.it

Cross + Morse
www.crossmorse.com

Cryotron Magnadrives
www.cmdindia.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Davall Gears Ltd.
www.davall.com

Desch Canada Ltd.
www.desch.on.ca

Designatronics, Inc.
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com
SEE OUR AD P7

DieQua Corp.
180 COVINGTON DRIVE
BLOOMINGDALE IL 60108
Phone: (630) 980-1133
Fax: (630) 980-1232
info@diequa.com
www.diequa.com
SEE OUR AD P12

Drive Lines Technologies Ltd
www.drivelines.co.uk

Electromatic Engineers Pvt. Ltd
www.clutchesbrakes.com

Emco Dynatorq Pvt. Ltd.
www.emco-dynatorq.in

Equipment Concepts
www.equipment-concepts.com

Flux Drive Inc.
www.fluxdrive.com

Force Control Indutries
www.forcecontrol.com

Formsprag Clutch
www.formsprag.com

GKN Land Systems
www.gknlandsystems.com

GMB Associates
www.gmbassociates.co.uk

GMN Bearing USA, Ltd.
www.gmnbt.com

Ghatge Patil Industries
www.gpi.co.in

Gummi USA
www.gummiusa.com

Hilliard Corp., The
www.hilliardcorp.com

Howdon Power Transmission Limited
www.howdon.com

Huco Dynatork
www.huco.com

IBT, Inc
www.ibtinc.com

ISC Companies
www.isccompanies.com

Industrial Clutch Parts Ltd.
www.icpltd.co.uk

Industrial Friction Materials Ltd.
www.industrialfriction.com

Inertia Dynamics, Inc.
www.idicb.com

J.W. Winco Inc. SEE OUR AD P2
2815 S. CALHOUN ROAD
NEW BERLIN WI 53151
Phone: (800) 877-8351
sales@jwwinco.com
www.jwwinco.com

KBK Antriebstechnik Gmbh
www.kbk-antriebstechnik.de

KTR Corporation SEE OUR ADS P21,39,47
122 ANCHOR ROAD
MICHIGAN CITY INDIANA 46360
Phone: (219) 872-9100
Fax: (219) 872-9150
ktr-us@ktr.com
www.ktr.com

MES INC
www.mesinc.net

Mach III Clutch Inc.
www.machiii.com

Magnetic Technologies Ltd
www.magnetictech.com

Magtrol, Inc.
www.magtrol.com

Marine Specialties, Inc.
www.marinespecialties-inc.com

Marshall Wolf Automation Inc.
www.wolfautomation.com

Matrix International
www.matrix-international.com

Mayr Corporation
www.mayrcorp.com

Means Industries, Inc.
www.meansindustries.com

Michigan Spline Gage Company
www.michiganspline.com

Midwest Brake
www.midwestbrake.com

Miki Pulley US SEE OUR AD P20
13200 6TH AVENUE NORTH
PLYMOUTH MN 55441
Phone: (800) 533-1731
Fax: (763) 546-8260
sales@mikipulley-us.com
www.mikipulley-us.com

Motion Industries
www.motionindustries.com

Moventas Ltd.
www.moventas.com

New Torque, Inc.
www.clutches-brakes.com

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

North American Clutch & Driveline
www.naclutch.com

Novotec Argentina SRL
www.novotecargentina.com

Orttech
www.orttech.com

PIC Design
www.pic-design.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Palmer Johnson Power Systems
www.pjpower.com

Pethe Engineering Private Limited
www.pethe.in

Power Transmission Engineers
www.ptegears.com

Precipart
www.precipart.com

R+W America SEE OUR AD P27
1120 TOWER LANE
BENSENVILLE IL 60106
Phone: (630) 521-9911
Fax: (630) 521-0366
info@rw-america.com
www.rw-america.com

René Baer AG
www.renebaerag.ch

Ringspann Corporation
www.ringspanncorp.com

Rockwell Automation
www.rockwellautomation.com

Rowland Co., The
www.rowland2.com

SBT Gearing Solutions
www.sbtgears.co.uk

Sipco-MLS
www.sipco-mls.com

Snow Nabstedt Power Transmissions Inc
www.snpt.biz

Sprockets Australia Pty. Ltd.
www.sprocketsoz.com.au

Stearns Division / Rexnord Industries Inc.
www.rexnord.com/stearns

Stephenson Gobin Transmissions
www.stephensongobin.com

Sterling Instrument
www.sdp-si.com

Stieber Clutch
www.stieber.de

Stock Drive Products
www.sdp-si.com

Supreme Gear Co.
www.supremegear.com

T.E.A. Machine Components
www.teausa.net

TB Wood's
www.tbwoods.com

Taiwan Precision Gear Corp.
www.tpg-tw.com

Team Industries
www.team-ind.com

Thomson Div. of Danaher
www.thomsonlinear.com

Tolomatic, Inc.
www.tolomatic.com

Transply Inc.
www.transply.com

Tristate Bearing & Supply Co. Inc.
www.tristatebearing.com

Twiflex Limited
www.twiflex.com

VL Motion Systems Inc.
www.vlmotion.com

Vortex Engineering Works
www.vortex-clutch.com

WPT Power Corporation
www.wptpower.com

CONTROLS

ACS Motion Control
www.acsmotioncontrol.com

Ace World Companies
www.aceworldcompanies.com

Advanced Control Systems Corporation
www.acsmotion.com

Aerotech Inc.
www.aerotech.com

Allied Motion
www.alliedmotion.com

American Rotary Industrial Power Source
www.americanrotary.com

Anaheim Automation, Inc.
www.anaheimautomation.com

Applied Dynamics
www.applied-dynamics.com

Applied Power Solutions
www.apscorp.com

Area Distributors Inc.
www.areadist.com

Automation Direct SEE OUR AD INSIDE FRONT COVER
3505 HUTCHINSON ROAD
CUMMING GA 30040
Phone: (800) 633-0405
Fax: (770) 889-7876
sales@automationdirect.com
www.automationdirect.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Baldor Electric Company SEE OUR AD P25
5711 R.S. BOREHAM, JR. ST.
P.O. BOX 2400
FORT SMITH AR 72901
Phone: (479) 646-4711
Fax: (479) 648-5792
www.baldor.com

Bearing Service Company
www.bearing-service.com

Binsfeld Engineering Inc.
www.binsfeld.com

Bodine Electric Company
www.bodine-electric.com

Bonfiglioli Riduttori S.p.A.
www.bonfiglioli.com

Bonfiglioli USA
www.BonfiglioliUSA.com

Boston Gear
www.bostongear.com

Carlyle Johnson Machine Co. LLC, The
www.cjmco.com

Chesterfield Electric Motors
www.chesterfieldelectricmotors.com

Conroll Corporation
www.conroll.com

Control Switches International Inc
www.controlswitches.com

Core Supply LLC
www.coresupplyllc.com

Custom Sensors & Technologies
www.cstsensors.com

Cutes Corporation
www.cutes.com.tw

Dalton Bearing Service, Inc.
www.daltonbearing.com

Dellner Brakes AB
www.dellner-brakes.com

DieQua Corp. SEE OUR AD P12
180 COVINGTON DRIVE
BLOOMINGDALE IL 60108
Phone: (630) 980-1133
Fax: (630) 980-1232
info@diequa.com
www.diequa.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

Duff Norton Sales South Pacific
www.dnsales.com.au

Dunkermotoren USA Inc.
www.dunkermotor.com

Dynamic Structures and Materials, Llc
www.dynamic-structures.com

Electronic Machine Parts
www.empregister.com

Emerson Industrial Automation - Drives & Motor
www.emersonindustrial.com

FSI Technologies Inc.
www.fsinet.com

Festo Corporation
www.festo.com/usa

Flux Drive Inc.
www.fluxdrive.com

Force Control Indutries
www.forcecontrol.com

GKN Land Systems
www.gknlandsystems.com

GMB Associates
www.gmbassociates.co.uk

HPB Motion Control Co. Ltd.
www.hpb-industry.com

Hallmark Industries Inc.
www.hallmarkind.com

Hansen Corporation
www.hansen-motor.com

Heidenhain Corporation
www.heidenhain.com

Hoffmann Technics AG
www.hoffmann-tech.ch

IBT, Inc
www.ibtinc.com

ISC Companies
www.isccompanies.com

Industrial Clutch Parts Ltd.
www.icpltd.co.uk

Inertia Dynamics, Inc.
www.idicb.com

Intellidrives, Inc
www.intellidrives.com

JVL Industri Elektronik A/S
www.jvl.dk

Johnson Industries Ltd.
www.brakes.ca

K+S Services
www.k-and-s.com

KB Controls
www.kb-controls.com

Kollmorgen Div. of Danaher
www.kollmorgen.com

Leeson Electric
www.leeson.com

MICO, Incorporated
www.mico.com

MROSupply
www.mrosupply.com

Magtrol, Inc.
www.magtrol.com

Marshall Wolf Automation Inc.
www.wolfautomation.com

Mavilor Motors, S.a.
www.mavilor.es

Maxcess
www.maxcessintl.com

Maxon Precision Motors Inc
www.maxonmotorusa.com

Micronor Inc.
www.micronor.com

Midwest Motion Products
www.midwestmotion.com

Mitsubishi Electric Automation, Inc.
us.mitsubishielectric.com/fa/en

Motion Industries
www.motionindustries.com

New Power Electric (USA) LLC
www.usa-newpower.com

New Torque, Inc.
www.clutches-brakes.com

Norwin Electronics Limited
www.norwin.co.uk

Novotec Argentina SRL
www.novotecargentina.com

Onvio LLC
www.onviollc.com

Ormec
www.ormec.com

PI (Physik Instrumente) L.P. Piezo Actuator Nano
www.pi-usa.us

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Parker Hannifin - SSD Drives Div.
www.ssddrives.com

Parker Hannifin SSD Drives Div.
www.parker.com/ssdusa

Phytron, Inc.
www.phytron.com

Potomac Electric
www.potomacelectric.com/

Precipart
www.precipart.com

Rae DC Products Group
www.raemotors.com

Regent Controls, Inc
www.regentcontrols.com

Rockwell Automation
www.rockwellautomation.com

Rowland Co., The
www.rowland2.com

SEW-Eurodrive
SEE OUR AD INSIDE BACK COVER
1295 OLD SPARTANBURG HWY.
P.O. BOX 518
LYMAN SC 29635
Phone: (864) 439-7537
Fax: (864) 439-7830
www.seweurodrive.com

SKF USA Inc.
SEE OUR AD P3
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com

Sesame Motor Corp.
SEE OUR AD P43
599, SEC. 1, HEMU RD.
SHENGANG TAICHUNG 42953
TAIWAN
Phone: +(886) 4-2561-0011
Fax: +(886) 4-2562-7766
info@sesamemotor.com.tw
www.sesamemotor.com.tw

Siemens Industry, Inc.
www.usa.siemens.com/industry/us/en

Siti Spa Riduttori
www.sitiriduttori.it

Source Engineering Inc.
www.sei-automation.com

Stearns Division / Rexnord Industries Inc.
www.rexnord.com/stearns

Taiwan Precision Gear Corp.
www.tpg-tw.com

Tampa Armature Works- TAW
www.tawinc.com

Tapeswitch Corporation
www.tapeswitch.com

Team Industries
www.team-ind.com

Teco Westinghouse
www.tecowestinghouse.com

TelcoMotion
www.telcointercon.com

Thomson Div. of Danaher
www.thomsonlinear.com

Tolomatic, Inc.
www.tolomatic.com

Transply Inc.
www.transply.com

Twiflex Limited
www.twiflex.com

VL Motion Systems Inc.
www.vlmotion.com

WEG
www.weg.net

WorldWide Electric
www.worldwideelectric.net

Yaskawa America, Inc.
www.yaskawa.com

COUPLINGS & U-JOINTS

AGI Automation Components
www.agi-automation.com

AISCO Industrial Couplings
www.aiscoinc.com

Accent Bearings Co. Inc.
www.accentbearing.com

Accurate Gear and Machine, Inc.
www.accurategear.com

Aciclon Equiptos Indls Ltda
www.aciclon.com.br

Acionac Indústria e Comércio Ltda
www.acionac.com.br

Acorn Industrial Services
www.acorn-ind.co.uk

Agro Engineers
www.agroengineers.com

AmTech International
www.amtechinternational.com

Ameridrives
www.ameridrives.com

Ameridrives Power Transmission
www.ameridrivespowertransmission.com

Ametric / American Metric Corporation
www.ametric.com

Applied Dynamics
www.applied-dynamics.com

Applied Power Solutions
www.apscorp.com

Area Distributors Inc.
www.areadist.com

Artec Machine Systems
www.artec-machine.com

Ascent Precision Gear Corporation
www.ascentgear.com

Atlanta Gear Works, Inc
www.gearboxrepair.com

Axu s.r.l.
www.axu.it/en

B & R Machine and Gear Corp.
SEE OUR AD P9
4809 U.S. HWY. 45
SHARON TN 38255
Phone: (731) 456-2636 or (800) 238-0651
Fax: (731) 456-3073
inquiry@brgear.com
www.brgear.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

BRECOflex CO., L.L.C.
www.brecoflex.com

Baker Bearing Company
www.bakerbearing.com

Bearing Service Company
www.bearing-service.com

Beijing THC Limited
www.beijingthc.com

Belcon Engineers P. Ltd.
www.belconengineers.com

Belden Universal
www.beldenuniversal.com

BellowsTech, LLC
www.bellowstech.com

Bervina
www.bervina.com

Bevel Gears India Pvt. Ltd.
www.jamalgears.co.in

Bibby Transmissions
www.bibbytransmissions.co.uk
Boneng Transmission USA LLC www.boneng.com/English

Boston Gear
www.bostongear.com

Brevini Power Transmission - Canada
www.brevini.com

C-B Gear & Machine
www.cbgear.com

CENTA Corp.
www.centa.info

Cabat Inc.
www.cabatinc.com

Carlyle Johnson Machine Co. LLC, The
www.cjmco.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Cestari Industrial e Comercial S.A.
www.cestari.com.br

Challenge Power Transmission (Aust) Pty Ltd
www.challengept.com

Challenge Power Transmission PLC
www.challengept.com

Chengdu Talent Industrial Co., Ltd.
www.ttindustrial.com

Climax Metal Products Company
www.climaxmetal.com

ComInTec Srl
www.comintec.it

Commercial Gear & Sprocket Co. Inc.
www.commercialgear.com

Core Supply LLC
www.coresupplyllc.com

Cross + Morse
www.crossmorse.com

Custom Machine & Tool Co. Inc.
www.cmtco.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Davall Gears Ltd.
www.davall.com

David Brown Gear Systems
www.davidbrown.com

DePe Gear Company Ltd
www.depe.co.uk

Desch Canada Ltd.
www.desch.on.ca

Designatronics, Inc.
SEE OUR AD P7
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com

DieQua Corp.
SEE OUR AD P12
180 COVINGTON DRIVE
BLOOMINGDALE IL 60108
Phone: (630) 980-1133
Fax: (630) 980-1232
info@diequa.com
www.diequa.com

Distag QCS
www.distag.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

Duff Norton Australia
www.duffnorton.com.au

Duff Norton Sales South Pacific
www.dnsales.com.au

Electro Steel Engineering Company
www.indiamart.com/tyginc

Electromatic Engineers Pvt. Ltd
www.clutchesbrakes.com

Equipment Concepts
www.equipment-concepts.com

Flexocon Engineers Private Limited
www.flexoconindia.com

Flux Drive Inc.
www.fluxdrive.com

Formsprag Clutch
www.formsprag.com

GAM Gear
www.gamweb.com

GKN Land Systems
www.gknlandsystems.com

GMB Associates
www.gmbassociates.co.uk

Gayatri Gear Industries
www.gayatrigear.com

Gear Master Inc.
www.gearmaster.us

Ghatge Patil Industries
www.gpi.co.in

Gleason K2 Plastics
www.k2plasticsinc.com

Gummi USA
www.gummiusa.com

Hangzhou Xingda Machinery Co. Ltd.
www.xdmade.com

Hayes Manufacturing Inc.
www.hayescouplings.com

Henan Contrust Gear Transmission Co., Ltd.
www.contrust-gear.com

Hi-Grade Inc.
www.higradeinc.com

Houston Pump and Gear
www.houstonpumpandgear.com

Huco Dynatork
www.huco.com

IBT, Inc
www.ibtinc.com

IDC Select
www.IDCselect.com

ISC Companies
www.isccompanies.com

Industrial Clutch Parts Ltd.
www.icpltd.co.uk

Inertia Dynamics, Inc.
www.idicb.com

KBK Antriebstechnik Gmbh
www.kbk-antriebstechnik.de

KTR Corporation
SEE OUR ADS P21,39,47
122 ANCHOR ROAD
MICHIGAN CITY INDIANA 46360
Phone: (219) 872-9100
Fax: (219) 872-9150
ktr-us@ktr.com
www.ktr.com

Kinefac Corporation
www.kinefac.com

Lovejoy, Inc.
www.lovejoy-inc.com

MAV S.p.A.
www.mav.it

MES INC
www.mesinc.net

MGT - Magnetic Gearing & Turbine Corp.
www.mgt.com.au

Mach III Clutch Inc.
www.machiii.com

Magnetic Technologies Ltd
www.magnetictech.com

Marine Specialties, Inc.
www.marinespecialties-inc.com

Martin Sprocket & Gear
www.martinsprocket.com

Master Bond, Inc.
www.masterbond.com

Matrix International
www.matrix-international.com

Maurey Manufacturing Corporation
www.maurey.com

Mayr Corporation
www.mayrcorp.com

Michigan Spline Gage Company
www.michiganspline.com

Miki Pulley US
SEE OUR AD P20
13200 6TH AVENUE NORTH
PLYMOUTH MN 55441
Phone: (800) 533-1731
Fax: (763) 546-8260
sales@mikipulley-us.com
www.mikipulley-us.com

Minsk Gear Works
www.mgw.by

Motion Industries
www.motionindustries.com

Moventas Ltd.
www.moventas.com

NDE Power Transmissions
www.ndepower.com

Netshape Technologies, Inc.
www.netshapetech.com

New Power Electric (USA) LLC
www.usa-newpower.com

Nordex, Inc.
SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

North American Clutch & Driveline
www.naclutch.com

Novotec Argentina SRL
www.novotecargentina.com

Nu-Teck Couplings Pvt. Ltd
www.nuteckcouplings.com

OEP Couplings, a Division of Oren Elliott Products
www.oepcouplings.com

Ondrives Ltd
www.ondrives.com

Orttech
www.orttech.com

PIC Design
www.pic-design.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Pacific Industries
www.pacificindustries.com

Palmer Johnson Power Systems
www.pjpower.com

Paul's Transmission Shenzhen Co.,ltd
www.chinatransmission.com.cn

Pix Transmissions Limited
www.pixtrans.com

Popular Mechanical Works
www.popularmechworks.com

Pylon Gears (Pty) Ltd
www.gearing.co.za

R+W America
SEE OUR AD P27
1120 TOWER LANE
BENSENVILLE IL 60106
Phone: (630) 521-9911
Fax: (630) 521-0366
info@rw-america.com
www.rw-america.com

Regal Power Transmission Solutions
www.regalpts.com

René Baer AG
www.renebaerag.ch

Ringball Corporation
www.ringball.com

Ringspann Corporation
www.ringspanncorp.com

Rowland Co., The
www.rowland2.com

Rubena a.s.
www.rubena.cz

Ruland Manufacturing Co., Inc.
www.ruland.com

SKF USA Inc.
SEE OUR AD P3
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com

Servometer
www.servometer.com

Siemens Energy & Automation
www.sea.siemens.com

Siemens Industry, Inc.
www.usa.siemens.com/industry/us/en

Sipco-MLS
www.sipco-mls.com

Sprockets Australia Pty. Ltd.
www.sprocketsoz.com.au

Sterling Instrument
www.sdp-si.com

Stock Drive Products
www.sdp-si.com

Stoffel Polygon Systems, Inc.
www.stoffelpolygon.com

Supreme Gear Co.
www.supremegear.com

T.E.A. Machine Components
www.teausa.net

TB Wood's
www.tbwoods.com

TSS Rotterdam B.V.
www.tssr.nl

TVT America, Inc.
www.tvtamerica.com

Taiwan Precision Gear Corp.
www.tpg-tw.com

Taiwan United Gear Co., Ltd.
www.tugear.com.tw

Team Industries
www.team-ind.com

Tien Yi Gear Works Co.,Ltd
www.tienyigear.com.tw

Timothy Holding Co., Ltd.
www.timothyholding.com

Transply Inc.
www.transply.com

Tristate Bearing & Supply Co. Inc.
www.tristatebearing.com

Tsubaki of Canada Limited
www.tsubaki.ca

Twiflex Limited
www.twiflex.com

VL Motion Systems Inc.
www.vlmotion.com

Vision International
www.engimech.com

Vision Qualitry Components, Inc
www.visionqci.com

WMH Transmissions Ltd
www.wmh-trans.co.uk

Wellman Wacoma Limited
www.wellmanwacoma.com

Wittenstein
www.wittenstein-us.com

Xtek, Inc.
www.xtek.com

Yogi Bearings
www.yogibearings.com

ZRIME
www.zrime.com.cn

Zero-Max
www.zero-max.com

FLUID POWER

Acorn Industrial Services
www.acorn-ind.co.uk

AmTech International
www.amtechinternational.com

Applied Dynamics
www.applied-dynamics.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Brevini Power Transmission - Canada
www.brevini.com

CENTA Corp.
www.centa.info

Chesterfield Electric Motors
www.chesterfieldelectricmotors.com

Cone Drive
www.conedrive.com

Cotta Transmission Co. LLC
www.cotta.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Dynex/Rivett Inc.
www.dynexhydraulics.com

Filter Pumper / Hydraulic Problems, Inc.
www.filterpumper.com

Hayes Manufacturing Inc.
www.hayescouplings.com

Helium Leak Testing, Inc.
www.heliumleaktesting.com

Houston Pump and Gear
www.houstonpumpandgear.com

IBT, Inc
www.ibtinc.com

ISC Companies
www.isccompanies.com

K+S Services
www.k-and-s.com

KTR Corporation
SEE OUR ADS P21,39,47
122 ANCHOR ROAD
MICHIGAN CITY INDIANA 46360
Phone: (219) 872-9100
Fax: (219) 872-9150
ktr-us@ktr.com
www.ktr.com

Lovejoy, Inc.
www.lovejoy-inc.com

MICO, Incorporated
www.mico.com

Motion Industries
www.motionindustries.com

NGT Specialty Valves
www.ngtvalves.com

Netshape Technologies, Inc.
www.netshapetech.com

Ningbo Zhongyi Hydraulic Motor Co. Ltd.
www.zihyd.com

OEM International Inc.
www.oeminternational.com

Orttech
www.orttech.com

Palmer Johnson Power Systems
www.pjpower.com

Popular Mechanical Works
www.popularmechworks.com

Rowland Co., The
www.rowland2.com

Rubena a.s.
www.rubena.cz

S.M. Shah & Company
www.hydraulicvanepump.com

Shanghai DE Mechanical Gears Co., Ltd.
www.gearvalves.com

T.E.A. Machine Components
www.teausa.net

TSS Rotterdam B.V.
www.tssr.nl

TVT America, Inc.
www.tvtamerica.com

Taiwan United Gear Co., Ltd.
www.tugear.com.tw

Techtop Industries, Inc.
www.techtopind.com

Var-Spe Variatori Oleodinamici
www.varspe.com

WorldWide Electric
www.worldwideelectric.net

Zero-Max
www.zero-max.com

GEAR DRIVES

ASI Technologies Inc.
www.asidrives.com

Accent Bearings Co. Inc.
www.accentbearing.com

Accurate Gear and Machine, Inc.
www.accurategear.com

Ace World Companies
www.aceworldcompanies.com

Acionac Indústria e Comércio Ltda
www.acionac.com.br

Acme Gear Co.
www.acmegear.com

Acorn Industrial Services
www.acorn-ind.co.uk

Aero Gear Inc.
www.aerogear.com

Agnee Transmissions (I) Pvt Ltd
www.agneetransmissions.com

Agro Engineers
www.agroengineers.com

Akgears, LLC
www.akgears.com

Akron Gear and Engineering
www.akrongear.com

Allen Gears Ltd.
www.allengears.com

Allied Motion
www.alliedmotion.com

AmTech International
www.amtechinternational.com

American Gear & Engineering
www.americangear.net

American Plastics Depot
www.americanplasticsdepot.com

Ametric / American Metric Corporation
www.ametric.com

Ancon Gear & Instrument Corp.
www.ancongear.com

Andantex USA Inc.
www.andantex.com

Applied Dynamics
www.applied-dynamics.com

Area Distributors Inc.
www.areadist.com

Arrow Gear Co.
SEE OUR AD P11
2301 CURTISS STREET
DOWNERS GROVE IL 60515
Phone: (630) 969-7640
Fax: (630) 969-0253
quote@arrowgear.com
www.arrowgear.com

Artec Machine Systems
www.artec-machine.com

Atlanta Drive Systems Inc.
www.atlantadrives.com

Atlanta Gear Works, Inc
www.gearboxrepair.com

Avion Technologies Inc.
www.avion-tech.com

B & R Machine and Gear Corp.
SEE OUR AD P9
4809 U.S. HWY. 45
SHARON TN 38255
Phone: (731) 456-2636 or (800) 238-0651
Fax: (731) 456-3073
inquiry@brgear.com
www.brgear.com

B&B Manufacturing, Inc.
www.bbman.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Baldor Electric Company
SEE OUR AD P25
5711 R.S. BOREHAM, JR. ST.
P.O. BOX 2400
FORT SMITH AR 72901
Phone: (479) 646-4711
Fax: (479) 648-5792
www.baldor.com

Bauer Gear Motor
www.bauergears.com

Bearing Service Company
www.bearing-service.com

Bevel Gears India Pvt. Ltd.
www.jamalgears.co.in

Bierens Machinefabrieken B.V.
www.bierens.com

Bison Gear and Engineering Corp.
www.bisongear.com

Bodine Electric Company
www.bodine-electric.com

Boneng Transmission (Suzhou) Co., Ltd.
www.boneng.com

Boneng Transmission USA LLC
www.boneng.com/English

Bonfiglioli Riduttori S.p.A.
www.bonfiglioli.com

Bonfiglioli USA
www.BonfiglioliUSA.com

Boston Gear
www.bostongear.com

Brad Foote Gear Works, Inc
www.bradfoote.com

IF THE GEARS DON'T WORK I DON'T WORK

NOT A PRETTY PICTURE

Never settle for close when you can have precision fit.

When it comes to the mechanical components you count on, close just doesn't cut it. Common sense says a poor fit and premature wear will eventually lead to failure. And no one has time for that. At Schafer, we specialize in custom, precision-fit products designed to keep equipment moving. Simply put, our service, quality and on-time delivery are second to none. Reliability is our trademark and it has helped us grow from Schafer Gear to Schafer Industries. These days, our expertise doesn't end with gears. Now we're leading the way in driveline, axle and brake applications as well. So whether you're in the automotive, truck, marine, off-road leisure, heavy equipment or aviation industry, look no further than Schafer. For more information visit us online.

SCHAFER
INDUSTRIES

SchaferIndustries.com

Brevini Gear Systems SEE OUR AD P23,50
2400 N. PRIORITY WAY
YORKTOWN IN 47396
Phone: (765) 702-1496
Fax: (765) 759-4728
chad.torn@brevinigear.com
www.brevinigear.com

Brevini Power Transmission - Canada
www.brevini.com

Broadway Gear
www.broadwaygear.com

Brother Gearmotors SEE OUR AD P37
200 CROSSING BLVD.
BRIDGEWATER NJ 08807
Phone: (866) 523-6283
Fax: (908) 575-3743
gearmotors@brother.com
www.brother-usa.com

Buehler Motor, Inc.
www.buehlermotor.com

C-B Gear & Machine
www.cbgear.com

Central Gear & Machine
www.cgmatlanta.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Cestari Industrial e Comercial S.A.
www.cestari.com.br

Challenge Power Transmission (Aust) Pty Ltd
www.challengept.com

Chenta USA
www.chenta.com

Chesterfield Electric Motors
www.chesterfieldelectricmotors.com

Chongqing IIYOU Industries Co., Ltd.
www.iiyouindustries.com

Cincinnati Gearing Systems SEE OUR AD P2
5757 MARIEMONT AVE.
CINCINNATI OH 45227
Phone: (513) 527-8600
Fax: (513) 527-8635
gearsales@cst-c.com
www.cincinnatigearingsystems.com

Cleveland Gear Co.
www.clevelandgear.com

Cogmatic
www.cogmatic.com

Columbia Gear Corp.
www.columbiagear.com

Cone Drive
www.conedrive.com

Cotta Transmission Co. LLC
www.cotta.com

Currie Enterprises
www.currieenterprises.com

Curtis Machine Co. Inc.
www.curtismachine.com

Custom Sensors & Technologies
www.cstsensors.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Davall Gears Ltd.
www.davall.com

David Brown Gear Systems
www.davidbrown.com

Delroyd Worm Gear
www.delroyd.com

Delta Gear Company
www.deltagearcompany.com

Desch Canada Ltd.
www.desch.on.ca

Designatronics, Inc. SEE OUR AD P7
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com

DieQua Corp. SEE OUR AD P12
180 COVINGTON DRIVE
BLOOMINGDALE IL 60108
Phone: (630) 980-1133
Fax: (630) 980-1232
info@diequa.com
www.diequa.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

Duff Norton Australia
www.duffnorton.com.au

Dunkermotoren USA Inc.
www.dunkermotor.com

EM Gear / Dae Seong Gear
www.em-gear.com

Electronic Machine Parts
www.empregister.com

Emerson Industrial Automation - Drives & Motor
www.emersonindustrial.com

Essential Power Transmission Pvt. Ltd.
www.esenpro.com

Excel Gear, Inc. SEE OUR AD P14
11865 MAIN STREET
ROSCOE IL 61073
Phone: 815-623-3414
Fax: 815-623-3314
chinn@excelgear.com
www.excelgear.com

Exlar Actuation Solutions
www.exlar.com

FMC Engineering
www.fmcengineering.com

Fairchild Industrial Products Co.
www.specontransmission.com

Foshan Xingguang Transmission Machinery Co. Ltd.
www.xg-cd.cn

Framo Morat Inc. SEE OUR AD P45
9440 SAN MATEO BLVD NE
SUITE L
ALBUQUERQUE NM 87113
Phone: (505) 359-2949
Fax: (505) 881-2070
sales@framo-morat.com
www.framo-morat.com

GAM Gear
www.gamweb.com

GKN Driveline
www.gkndriveline.com

GMB Associates
www.gmbassociates.co.uk

Gayatri Gear Industries
www.gayatrigear.com

Ghatge Patil Industries
www.gpi.co.in

Gleason K2 Plastics
www.k2plasticsinc.com

Groschopp Inc.
www.groschopp.com

HPB Motion Control Co. Ltd.
www.hpb-industry.com

Hallmark Industries Inc.
www.hallmarkind.com

Hangzhou Xingda Machinery Co. Ltd.
www.xdmade.com

Harmonic Drive LLC
www.hdsystems.net

Haumea Srl
www.haumea.com

Henan Contrust Gear Transmission Co., Ltd.
www.contrust-gear.com

Hoffmann Technics AG
www.hoffmann-tech.ch

Houston Pump and Gear
www.houstonpumpandgear.com

IBT, Inc
www.ibtinc.com

ISC Companies
www.isccompanies.com

ITW Heartland
www.itwheartland.com

Industrial Jig & Fixture
www.industrialjigandfixture.com

Innovative Rack & Gear SEE OUR AD P17
365 BALM COURT
WOOD DALE IL 60191
Phone: (630) 766-2652
Fax: (630) 766-3245
info@gearacks.com
www.gearacks.com

JVL Industri Elektronik A/S
www.jvl.dk

Jahnel - Kestermann Gmbh & Co. Kg
www.jake-gear.com

K+S Services
www.k-and-s.com

Kamar Industries
www.kamarindustries.com

Kisco Gears
www.kiscogears.com

Kollmorgen Div. of Danaher
www.kollmorgen.com

Koro Industries, Inc.
www.koroind.com

Lafert North America SEE OUR AD P13
5620 KENNEDY RD.
MISSISSAUGA ON L4Z 2A9
CANADA
Phone: (905) 629-1939 or
toll free (800) 661-6413
Fax: (905) 629-2852
sales@lafertna.com
www.lafertna.com

Leeson Electric
www.leeson.com

Marswell Engineering Ltd.
www.marswell.com

Maxon Precision Motors Inc
www.maxonmotorusa.com

Michigan Spline Gage Company
www.michiganspline.com

Midwest Gear & Tool, Inc.
www.powertransmission.com/copage/956_Midwest-Gear/

Midwest Motion Products
www.midwestmotion.com

Mijno Precision Gearing
www.mijno.com

Miki Pulley US SEE OUR AD P20
13200 6TH AVENUE NORTH
PLYMOUTH MN 55441
Phone: (800) 533-1731
Fax: (763) 546-8260
sales@mikipulley-us.com
www.mikipulley-us.com

Minsk Gear Works
www.mgw.by

Motion Industries
www.motionindustries.com

Moventas Ltd.
www.moventas.com

NAC Drive Systems
www.nacdrivesystems.com

New Power Electric (USA) LLC
www.usa-newpower.com

Niebuhr Gears
www.niebuhr.dk

Ningbo Zhongyi Hydraulic Motor Co. Ltd.
www.zihyd.com

Nord Gear Corp. USA
www.nord.com

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

Norwin Electronics Limited
www.norwin.co.uk

Ondrives Ltd
www.ondrives.com

Onvio LLC
www.onviollc.com

Ormec
www.ormec.com

P. G. DRIVE
www.pgdrive.com

PIC Design
www.pic-design.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Palmer Johnson Power Systems
www.pjpower.com

Parker Hannifin SSD Drives Div.
www.parker.com/ssdusa

Performance Gear Systems, Inc.
www.performance-gear.com

Phytron, Inc.
www.phytron.com

Plastock - Putnam Precision Molding, Inc.
www.plastockonline.com

Popular Mechanical Works
www.popularmechworks.com

Portescap
www.portescap.com

Power Engineering and Manufacturing
www.pemltd.com

Power Transmission Engineers
www.ptegears.com

Precipart
www.precipart.com

Precision Microdrives Limited
www.precisionmicrodrives.com

Pylon Gears (Pty) Ltd
www.gearing.co.za

QTC Metric Gears
www.qtcgears.com

Quality Reducer Service
www.qualityreducer.com

RJ Link International, Inc.
www.rjlink.com

Rae DC Products Group
www.raemotors.com

Regal Power Transmission Solutions
www.regalpts.com

Renk Test Systems
www.renklabeco.com

Rex Engineering Corp.
www.rex-engineering.com

Ringball Corporation
www.ringball.com

Rockwell Automation
www.rockwellautomation.com

Rowland Co., The
www.rowland2.com

SEW-Eurodrive SEE OUR AD INSIDE BACK COVER
1295 OLD SPARTANBURG HWY.
P.O. BOX 518
LYMAN SC 29635
Phone: (864) 439-7537
Fax: (864) 439-7830
www.seweurodrive.com

SPN Schwaben Praezision
www.spn-hopf.de

Sallex Machine Tools
www.sallex.com

Sam Gears India Pvt.ltd
www.samgears.com

Sesame Motor Corp. SEE OUR AD P43
599, SEC. 1, HEMU RD.
SHENGANG TAICHUNG 42953
TAIWAN
Phone: +(886) 4-2561-0011
Fax: +(886) 4-2562-7766
info@sesamemotor.com.tw
www.sesamemotor.com.tw

Setco Precision Spindles, Slides & Service
www.setcousa.com

Siemens Energy & Automation
www.sea.siemens.com

Siemens Industry, Inc.
www.usa.siemens.com/industry/us/en

Sinotech
www.sinotech.com

Sipco-MLS
www.sipco-mls.com

Siti Spa Riduttori
www.sitiriduttori.it

Snow Nabstedt Power Transmissions Inc
www.snpt.biz

Sokhi Heli-Wom Gears Pvt. Ltd.
www.gearboxindia.com

Source Engineering Inc.
www.sei-automation.com

Spencer Pettus
www.spgear.com

Spline Gauges
splinegauges.co.uk

Star Gears
www.stargears.in

Sterling Instrument
www.sdp-si.com

Stober Drives, Inc.
www.stober.com

Stock Drive Products
www.sdp-si.com

Stoffel Polygon Systems, Inc.
www.stoffelpolygon.com

Sumitomo Machinery Corp. of America
www.smcyclo.com

Supreme Gear Co.
www.supremegear.com

T.E.A. Machine Components
www.teausa.net

TVT America, Inc.
www.tvtamerica.com

Taiwan Precision Gear Corp.
www.tpg-tw.com

Taiwan United Gear Co., Ltd.
www.tugear.com.tw

Tampa Armature Works- TAW
www.tawinc.com

Team Industries
www.team-ind.com

TelcoMotion
www.telcointercon.com

Thomson Div. of Danaher
www.thomsonlinear.com

Tien Yi Gear Works Co.,Ltd
www.tienyigear.com.tw

Toledo Gearmotor
www.toledogear.com

Tolomatic, Inc.
www.tolomatic.com

Torque Transmission
www.torquetrans.com

Transply Inc.
www.transply.com

Tristate Bearing & Supply Co. Inc.
www.tristatebearing.com

Triumph Gear Systems - Acr Industries
www.triumphgroup.com

Trojon Gear Inc.
www.trojon-gear.com

VL Motion Systems Inc.
www.vlmotion.com

Var-Spe Variatori Oleodinamici
www.varspe.com

WEG
www.weg.net

WMH Transmissions Ltd
www.wmh-trans.co.uk

WPT Power Corporation
www.wptpower.com

Wittenstein
www.wittenstein-us.com

WorldWide Electric
www.worldwideelectric.net

Xtek, Inc.
www.xtek.com

Yilmaz Reduktor Sanayi ve Tic A.S.
www.yr.com.tr

ZRIME
www.zrime.com.cn

ZZN Transmission Plant
www.zzn-transmissions.com

Zero-Max
www.zero-max.com

Zhengzhou AOKMAN Machinery Co. Ltd.
www.aokman-gearbox.com

GEAR MANUFACTURING SERVICES

ABL Products Incorporated
www.ablproducts.com

ASI Technologies Inc.
www.asidrives.com

ATA Gears Ltd.
www.atagears.fi

Accent Bearings Co. Inc.
www.accentbearing.com

Accurate Gear and Machine, Inc.
www.accurategear.com

Ace World Companies
www.aceworldcompanies.com

Acme Gear Co.
www.acmegear.com

Acorn Industrial Services
www.acorn-ind.co.uk

Agnee Transmissions (I) Pvt Ltd
www.agneetransmissions.com

Agro Engineers
www.agroengineers.com

Allen Gears Ltd.
www.allengears.com

Allied Gear Co.
www.thealliedgearco.com

Allied Specialty Precision Inc.
www.aspi-nc.com

AmTech International
www.amtechinternational.com

American Gear & Engineering
www.americangear.net

American Gear, Inc.
www.americangearinc.com

American Plastics Depot
www.americanplasticsdepot.com

American Swiss Products Co., Inc.
www.americanswiss.com

Ametric / American Metric Corporation
www.ametric.com

Ancon Gear & Instrument Corp.
www.ancongear.com

Applied Dynamics
www.applied-dynamics.com

Artec Machine Systems
www.artec-machine.com

Ascent Precision Gear Corporation
www.ascentgear.com

Atlanta Gear Works, Inc
www.gearboxrepair.com

Avion Technologies Inc.
www.avion-tech.com

B & R Machine and Gear Corp. SEE OUR AD P9
4809 U.S. HWY. 45
SHARON TN 38255
Phone: (731) 456-2636 or (800) 238-0651
Fax: (731) 456-3073
inquiry@brgear.com
www.brgear.com

B&B Manufacturing, Inc.
www.bbman.com

BC Gear Inc
www.precisiongearmanufacturers.com

Bearing Service Company
www.bearing-service.com

Beaver Aerospace and Defense Inc.
www.beaver-online.com

Beyta Gear Service SEE OUR AD P83
0N230 COUNTY FARM ROAD
WINFIELD, IL 60190
chuck@beytagear.com
www.beytagear.com

Bharat Gears Ltd.
www.bharatgears.com

Bierens Machinefabrieken B.V.
www.bierens.com

Brelie Gear Company, Inc
www.breliegear.com

Brevini Gear Systems SEE OUR ADS P23,50
2400 N. PRIORITY WAY
YORKTOWN IN 47396
Phone: (765) 702-1496
Fax: (765) 759-4728
chad.torn@brevinigear.com
www.brevinigear.com

Brevini Power Transmission - Canada
www.brevini.com

Broadway Gear
www.broadwaygear.com

Buffalo Gear, Inc.
www.buffalogear.com

Butler Gear
www.butlergear.com

C-B Gear & Machine
www.cbgear.com

Carnes-Miller Gear Co., Inc.
www.cmgear.com

Cattini & Figlio s.r.l.
www.cattini.com

Central Gear & Machine
www.cgmatlanta.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Chenta USA
www.chenta.com

Chongqing IIYOU Industries Co., Ltd.
www.iiyouindustries.com

Cincinnati Gearing Systems SEE OUR AD P2
5757 MARIEMONT AVE.
CINCINNATI OH 45227
Phone: (513) 527-8600
Fax: (513) 527-8635
gearsales@cst-c.com
www.cincinnatigearingsystems.com

Circle Gear & Machine Co. SEE OUR AD P16
1501 S. 55TH COURT
CICERO IL 60804
Phone: (708) 652-1000
Fax: (708) 652-1100
sales@circlegear.com
www.circlegear.com

Clark Gear Works, Inc.
www.clarkgearworks.com

Clarke Engineering Inc. (Clarke Gear Co.) SEE OUR AD P54
8058 LANKERSHIM BLVD.
NORTH HOLLYWOOD, CA 91605
Phone: (818) 768-0690
Fax: (818) 767-5577
clarkegear@earthlink.net
www.clarkegear.com

Cleveland Gear Co.
www.clevelandgear.com

Cloyes Gear & Products Inc.
www.cloyes.com

Cogmatic
www.cogmatic.com

Columbia Gear Corp.
www.columbiagear.com

Commercial Gear & Sprocket Co. Inc.
www.commercialgear.com

Cone Drive
www.conedrive.com

Cross + Morse
www.crossmorse.com

Curtis Machine Co. Inc.
www.curtismachine.com

Custom Gear & Machine Inc.
www.cgearinc.com

Custom Machine & Tool Co. Inc.
www.cmtco.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Davall Gears Ltd.
www.davall.com

David Brown Gear Systems
www.davidbrown.com

Delroyd Worm Gear
www.delroyd.com

Delta Gear Company
www.deltagearcompany.com

Delta Gear Corp.
www.delta-gear.com

Desch Canada Ltd.
www.desch.on.ca

Designatronics, Inc. SEE OUR AD P7
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

EM Gear / Dae Seong Gear
www.em-gear.com

Electronic Machine Parts
www.empregister.com

Excel Gear, Inc. SEE OUR AD P14
11865 MAIN STREET
ROSCOE IL 61073
Phone: 815-623-3414
Fax: 815-623-3314
chinn@excelgear.com
www.excelgear.com

FMC Engineering
www.fmcengineering.com

Forest City Gear Co. SEE OUR AD P5
11715 MAIN STREET
ROSCOE IL 61073
Phone: (815) 623-2168
Fax: (815) 623-6620
www.fcgear.com

Foshan Xingguang Transmission Machinery Co. Ltd.
www.xg-cd.cn

Framo Morat Inc. SEE OUR AD P45
9440 SAN MATEO BLVD NE
SUITE L
ALBUQUERQUE NM 87113
Phone: (505) 359-2949
Fax: (505) 881-2070
sales@framo-morat.com
www.framo-morat.com

GKN Driveline
www.gkndriveline.com

GMB Associates
www.gmbassociates.co.uk

Gajra Gears Pvt. Ltd.
www.gajra.com

Gayatri Gear Industries
www.gayatrigear.com

Gear Design & Service Pty. Ltd.
www.geardesign.com.au

Gear Master Inc.
www.gearmaster.us

Gleason K2 Plastics
www.k2plasticsinc.com

Havlik Gear
www.havlikgear.com

Hayes Manufacturing Inc.
www.hayescouplings.com

Hoffmann Technics AG
www.hoffmann-tech.ch

Houston Pump and Gear
www.houstonpumpandgear.com

IBT, Inc
www.ibtinc.com

ISC Companies
www.isccompanies.com

ITW Heartland
www.itwheartland.com

Industrial Jig & Fixture
www.industrialjigandfixture.com

Innovative Rack & Gear SEE OUR AD P17
365 BALM COURT
WOOD DALE IL 60191
Phone: (630) 766-2652
Fax: (630) 766-3245
info@gearacks.com
www.gearacks.com

Jahnel - Kestermann Gmbh & Co. Kg
www.jake-gear.com

Kamar Industries
www.kamarindustries.com

Kinefac Corporation
www.kinefac.com

Kisco Gears
www.kiscogears.com

Kleiss Gears, Inc.
www.kleissgears.com

Koro Industries, Inc.
www.koroind.com

MT Tool & Manufacturing
www.ourmachinist.com

Magnum Manufacturing
www.magnum-mfg.com

Marswell Engineering Ltd.
www.marswell.com

Martin Sprocket & Gear
www.martinsprocket.com

Michigan Spline Gage Company
www.michiganspline.com

Mijno Precision Gearing
www.mijno.com

Mini-Broach Machine Company
www.minibroach.com

Minsk Gear Works
www.mgw.by

Moventas Ltd.
www.moventas.com

New Allenberry Works (Deepak Industries Ltd.)
www.allenberrygears.com

Niebuhr Gears
www.niebuhr.dk

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

Ontario Gear and Spline
www.ontariogearandspline.com

Onvio LLC
www.onviollc.com

P. G. DRIVE
www.pgdrive.com

PIC Design
www.pic-design.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Performance Gear Systems, Inc.
www.performance-gear.com

Phoenix Tool & Thread Grinding
www.phoenixthreadgrinding.com

Popular Mechanical Works
www.popularmechworks.com

Power Engineering and Manufacturing
www.pemltd.com

Pragati Transmission Pvt Ltd
www.pragatigears.com

Precipart
www.precipart.com

Precision Screw Thread
www.precisionscrewthread.com

Precision Technologies Group (PTG) Ltd.
www.ptgltd.com

Pulley Manufacturers International Inc.
www.pulleys.com

Pylon Gears (Pty) Ltd
www.gearing.co.za

QTC Metric Gears
www.qtcgears.com

Quality Reducer Service
www.qualityreducer.com

RJ Link International, Inc.
www.rjlink.com

Rave Gears LLC SEE OUR AD P19
425 STREMPLE DRIVE
SEGUIN TX 78115
Phone: (855) 728-4327
Fax: (830) 421-3532
sales@ravegears.com
www.ravegears.com

Renk Test Systems
www.renklabeco.com

Ronson Gears Pty. Ltd.
www.ronsongears.com

Rotek
www.rotek-inc.com

Rush Gears Inc.
www.rushgears.com

SBT Gearing Solutions
www.sbtgears.co.uk

SPN Schwaben Praezision
www.spn-hopf.de

ST Gear & Machine LLC
www.stgearandmachine.com

Sam Gears India Pvt.ltd
www.samgears.com

Schafer Industries SEE OUR AD P49
4701 NIMTZ PARKWAY
SOUTH BEND IN 46628-6151
Phone: (574) 234-4116
Fax: (574) 234-4115
pshah@schafergear.com
www.schafergear.com

Shanghai DE Mechanical Gears Co., Ltd.
www.gearvalves.com

Shivam Autotech Ltd.
www.shivamautotech.com

Sipco-MLS
www.sipco-mls.com

Sokhi Heli-Wom Gears Pvt. Ltd.
www.gearboxindia.com

Spencer Pettus
www.spgear.com

Sprockets Australia Pty. Ltd.
www.sprocketsoz.com.au

Steelmans Broaches Pvt Ltd
www.steelmans.com

Sterling Instrument
www.sdp-si.com

Stock Drive Products
www.sdp-si.com

Stoffel Polygon Systems, Inc.
www.stoffelpolygon.com

Suhner Manufacturing Inc. SEE OUR AD P83
43 ANDERSON ROAD
ROME GA 30161
Phone: (706) 235-8046
Fax: (706) 235-8045
info.usa@suhner.com
www.suhner.com

Supreme Gear Co.
www.supremegear.com

Suzhou Asia Pacific Metal Co., Ltd.
www.szapmc.com

Taiwan Precision Gear Corp.
www.tpg-tw.com

Taiwan United Gear Co., Ltd.
www.tugear.com.tw

Talon Machine & Gear Inc.
www.talonmachine.com

Team Industries
www.team-ind.com

Tien Yi Gear Works Co.,Ltd
www.tienyigear.com.tw

Toledo Gearmotor
www.toledogear.com

Trojon Gear Inc.
www.trojon-gear.com

Unigear Industries
www.unigear.com

VCST LP
www.vcst.be

VW Broaching Service Inc.
www.vwbroaching.com

Vision Qualitry Components, Inc
www.visionqci.com

WEG
www.weg.net

WMH Transmissions Ltd
www.wmh-trans.co.uk

ZRIME
www.zrime.com.cn

ZZN Transmission Plant
www.zzn-transmissions.com

GEARS

ABL Products Incorporated
www.ablproducts.com

ASI Technologies Inc.
www.asidrives.com

AST Bearings
www.astbearings.com

ATA Gears Ltd.
www.atagears.fi

Accent Bearings Co. Inc.
www.accentbearing.com

Accurate Gear and Machine, Inc.
www.accurategear.com

Acedes Gear Tools
www.acedes.co.uk

Acme Gear Co.
www.acmegear.com

Aero Gear Inc.
www.aerogear.com

Agnee Transmissions (I) Pvt Ltd
www.agneetransmissions.com

Agro Engineers
www.agroengineers.com

Akgears, LLC
www.akgears.com

Akron Gear and Engineering
www.akrongear.com

Allen Gears Ltd.
www.allengears.com

Allied Gear Co.
www.thealliedgearco.com

Allied Specialty Precision Inc.
www.aspi-nc.com

AmTech International
www.amtechinternational.com

American Gear & Engineering
www.americangear.net

American Gear, Inc.
www.americangearinc.com

American Plastics Depot
www.americanplasticsdepot.com

American Swiss Products Co., Inc.
www.americanswiss.com

Ameridrives Power Transmission
www.ameridrivespowertransmission.com

Ametric / American Metric Corporation
www.ametric.com

Ancon Gear & Instrument Corp.
www.ancongear.com

Andantex USA Inc.
www.andantex.com

Area Distributors Inc.
www.areadist.com

Arrow Gear Co. SEE OUR AD P11
2301 CURTISS STREET
DOWNERS GROVE IL 60515
Phone: (630) 969-7640
Fax: (630) 969-0253
quote@arrowgear.com
www.arrowgear.com

Artec Machine Systems
www.artec-machine.com

Ascent Precision Gear Corporation
www.ascentgear.com

Atlanta Drive Systems Inc.
www.atlantadrives.com

Atlanta Gear Works, Inc
www.gearboxrepair.com

Avion Technologies Inc.
www.avion-tech.com

B & R Machine and Gear Corp. SEE OUR AD P9
4809 U.S. HWY. 45
SHARON TN 38255
Phone: (731) 456-2636 or (800) 238-0651
Fax: (731) 456-3073
inquiry@brgear.com
www.brgear.com

B&B Manufacturing, Inc.
www.bbman.com

BC Gear Inc
www.precisiongearmanufacturers.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Baldor Electric Company SEE OUR AD P25
5711 R.S. BOREHAM, JR. ST.
P.O. BOX 2400
FORT SMITH AR 72901
Phone: (479) 646-4711
Fax: (479) 648-5792
www.baldor.com

Bearings Limited
www.bearingslimited.com

Beaver Aerospace and Defense Inc.
www.beaver-online.com

Befared
www.befared.com.pl

Beijing THC Limited
www.beijingthc.com

Bevel Gears India Pvt. Ltd.
www.jamalgears.co.in

Bharat Gears Ltd.
www.bharatgears.com

Bierens Machinefabrieken B.V.
www.bierens.com

Bison Gear and Engineering Corp.
www.bisongear.com

Bonfiglioli Riduttori S.p.A.
www.bonfiglioli.com

Boston Gear
www.bostongear.com

Brad Foote Gear Works, Inc
www.bradfoote.com

Brelie Gear Company, Inc
www.breliegear.com

Brevini Gear Systems SEE OUR ADS P23,50
2400 N. PRIORITY WAY
YORKTOWN IN 47396
Phone: (765) 702-1496
Fax: (765) 759-4728
chad.torn@brevinigear.com
www.brevinigear.com

Brevini Power Transmission - Canada
www.brevini.com

Brevini USA
www.breviniusa.com/index.asp

Brewer Machine & Gear Co.
www.brewertensioner.com

Broadway Gear
www.broadwaygear.com

Brother Gearmotors SEE OUR AD P37
200 CROSSING BLVD.
BRIDGEWATER NJ 08807
Phone: (866) 523-6283
Fax: (908) 575-3743
gearmotors@brother.com
www.brother-usa.com

Buffalo Gear, Inc.
www.buffalogear.com

Butler Gear
www.butlergear.com

C&U Americas, LLC
www.cubearing.com

C-B Gear & Machine
www.cbgear.com

CIMA S.p.A.
www.cimaingranaggi.it

Capstan Atlantic
www.capstanatlantic.com

Carnes-Miller Gear Co., Inc.
www.cmgear.com

Cattini & Figlio s.r.l.
www.cattini.com

Central Gear & Machine
www.cgmatlanta.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Chenta USA
www.chenta.com

Chongqing IIYOU Industries Co., Ltd.
www.iiyouindustries.com

Chongqing Rainbow M&E Co., Ltd.
www.cqrainbow.com

Cincinnati Gearing Systems SEE OUR AD P2
5757 MARIEMONT AVE.
CINCINNATI OH 45227
Phone: (513) 527-8600
Fax: (513) 527-8635
gearsales@cst-c.com
www.cincinnatigearingsystems.com

Circle Gear & Machine Co. SEE OUR AD P16
1501 S. 55TH COURT
CICERO IL 60804
Phone: (708) 652-1000
Fax: (708) 652-1100
sales@circlegear.com
www.circlegear.com

Clark Gear Works, Inc.
www.clarkgearworks.com

Clarke Engineering Inc. (Clarke Gear Co.) SEE OUR AD P54
8058 LANKERSHIM BLVD.
NORTH HOLLYWOOD, CA 91605
Phone: (818) 768-0690
Fax: (818) 767-5577
clarkegear@earthlink.net
www.clarkegear.com

Cleveland Gear Co.
www.clevelandgear.com

Cloyes Gear & Products Inc.
www.cloyes.com

Cogmatic
www.cogmatic.com

Columbia Gear Corp.
www.columbiagear.com

Commercial Gear & Sprocket Co. Inc.
www.commercialgear.com

Cone Drive
www.conedrive.com

Cross + Morse
www.crossmorse.com

Curtis Machine Co. Inc.
www.curtismachine.com

Custom Gear & Machine Inc.
www.cgearinc.com

Custom Machine & Tool Co. Inc.
www.cmtco.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Davall Gears Ltd.
www.davall.com

David Brown Gear Systems
www.davidbrown.com

DePe Gear Company Ltd
www.depe.co.uk

Delroyd Worm Gear
www.delroyd.com

Delta Gear Company
www.deltagearcompany.com

Delta Gear Corp.
www.delta-gear.com

Delta Research Corp.
www.deltaresearch.com

Desch Canada Ltd.
www.desch.on.ca

Designatronics, Inc. SEE OUR AD P7
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

Dunkermotoren USA Inc.
www.dunkermotor.com

EM Gear / Dae Seong Gear
www.em-gear.com

Electronic Machine Parts
www.empregister.com

Essential Power Transmission Pvt. Ltd.
www.esenpro.com

Excel Gear, Inc. SEE OUR AD P14
11865 MAIN STREET
ROSCOE IL 61073
Phone: 815-623-3414
Fax: 815-623-3314
chinn@excelgear.com
www.excelgear.com

FMC Engineering
www.fmcengineering.com

First Gear Engineering & Technology
www.first-gear.com

Forest City Gear Co. SEE OUR AD P5
11715 MAIN STREET
ROSCOE IL 61073
Phone: (815) 623-2168
Fax: (815) 623-6620
www.fcgear.com

Framo Morat Inc. SEE OUR AD P45
9440 SAN MATEO BLVD NE
SUITE L
ALBUQUERQUE NM 87113
Phone: (505) 359-2949
Fax: (505) 881-2070
sales@framo-morat.com
www.framo-morat.com

GKN Driveline
www.gkndriveline.com

GMB Associates
www.gmbassociates.co.uk

GMN Bearing USA, Ltd.
www.gmnbt.com

Gajra Gears Pvt. Ltd.
www.gajra.com

Gayatri Gear Industries
www.gayatrigear.com

Gear Design & Service Pty. Ltd.
www.geardesign.com.au

Gear Manufacturing Inc.
www.gearmfg.com

Gear Master Inc.
www.gearmaster.us

Gleason K2 Plastics
www.k2plasticsinc.com

Groschopp Inc.
www.groschopp.com

Hangzhou Xingda Machinery Co. Ltd.
www.xdmade.com

Havlik Gear
www.havlikgear.com

Hayes Manufacturing Inc.
www.hayescouplings.com

Henan Contrust Gear Transmission Co., Ltd.
www.contrust-gear.com

Hoffmann Technics AG
www.hoffmann-tech.ch

Houston Pump and Gear
www.houstonpumpandgear.com

IBT, Inc
www.ibtinc.com

IDC Select
www.IDCselect.com

IG Watteeuw USA
www.igwpower.com

ISC Companies
www.isccompanies.com

ITW Heartland
www.itwheartland.com

Industrial Jig & Fixture
www.industrialjigandfixture.com

Industrial Pulley & Machine Co, Inc.
www.industrialpulley.com

Innovative Rack & Gear SEE OUR AD P17
365 BALM COURT
WOOD DALE IL 60191
Phone: (630) 766-2652
Fax: (630) 766-3245
info@gearacks.com
www.gearacks.com

Intech Corporation
www.intechpower.com

Involute Simulation Software Inc.
www.hygears.com

JVL Industri Elektronik A/S
www.jvl.dk

Jahnel - Kestermann Gmbh & Co. Kg
www.jake-gear.com

Kamar Industries
www.kamarindustries.com

Kaydon Corporation Bearings Division
www.kaydonbearings.com

Kisco Gears
www.kiscogears.com

Kleiss Gears, Inc.
www.kleissgears.com

Koro Industries, Inc.
www.koroind.com

LYC North America Inc
www.lycbearings.com

Luoyang SBI Special Bearing Co. Ltd.
www.sbibearings.com

MT Tool & Manufacturing
www.ourmachinist.com

Magnum Manufacturing
www.magnum-mfg.com

Marswell Engineering Ltd.
www.marswell.com

Martin Sprocket & Gear
www.martinsprocket.com

McInnes Rolled Rings SEE OUR AD P22
1533 EAST 12TH STREET
ERIE PA 16511
Phone: (814) 459-4495
Fax: (814) 459-8443
sales@mcrings.com
www.mcinnesrolledrings.com

Michigan Spline Gage Company
www.michiganspline.com

Midwest Gear & Tool, Inc.
www.powertransmission.com/copage/956_Midwest-Gear/

Midwest Motion Products
www.midwestmotion.com

Mijno Precision Gearing
www.mijno.com

Mini Gears (Stockport) Ltd.
www.minigears.co.uk

Mini-Broach Machine Company
www.minibroach.com

Minsk Gear Works
www.mgw.by

Motion Industries
www.motionindustries.com

Moventas Ltd.
www.moventas.com

Netshape Technologies, Inc.
www.netshapetech.com

New Allenberry Works (Deepak Industries Ltd.)
www.allenberrygears.com

Niebuhr Gears
www.niebuhr.dk

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

Nu-Teck Couplings Pvt. Ltd
www.nuteckcouplings.com

Ongears - Ondrives Export Gears
www.ongears.co.uk

Ontario Gear and Spline
www.ontariogearandspline.com

P. G. DRIVE
www.pgdrive.com

PIC Design
www.pic-design.com

PSL of America
www.pslofamerica.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Performance Gear Systems, Inc.
www.performance-gear.com

Plastock - Putnam Precision Molding, Inc.
www.plastockonline.com

Popular Mechanical Works
www.popularmechworks.com

Portescap
www.portescap.com

Pragati Transmission Pvt Ltd
www.pragatigears.com

Precipart
www.precipart.com

Precision Screw Thread
www.precisionscrewthread.com

Precision Technologies Group (PTG) Ltd.
www.ptgltd.com

Pulley Manufacturers International Inc.
www.pulleys.com

Pylon Gears (Pty) Ltd
www.gearing.co.za

QTC Metric Gears
www.qtcgears.com

Quality Bearings & Components
www.qbcbearings.com

RBI Bearing Inc.
www.rbibearing.com

RJ Link International, Inc.
www.rjlink.com

Rave Gears LLC SEE OUR AD P19
425 STREMPLE DRIVE
SEGUIN TX 78115
Phone: (855) 728-4327
Fax: (830) 421-3532
sales@ravegears.com
www.ravegears.com

Regal Power Transmission Solutions
www.regalpts.com

Ringball Corporation
www.ringball.com

Ritbearing Corp.
www.ritbearing.com

Ronson Gears Pty. Ltd.
www.ronsongears.com

Rotek
www.rotek-inc.com

Rush Gears Inc.
www.rushgears.com

SBT Gearing Solutions
www.sbtgears.co.uk

SKF USA Inc. SEE OUR AD P3
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com

SPN Schwaben Praezision
www.spn-hopf.de

ST Gear & Machine LLC
www.stgearandmachine.com

Sallex Machine Tools
www.sallex.com

Sam Gears India Pvt.ltd
www.samgears.com

Schaeffler Group USA, Inc SEE OUR AD BACK COVER
308 SPRINGHILL FARM ROAD
FORT MILL SC 29715
Phone: (803) 548-8500
Fax: (803) 548-8599
info.us@schaeffler.com
www.schaeffler.us

Schafer Industries SEE OUR AD P49
4701 NIMTZ PARKWAY
SOUTH BEND IN 46628-6151
Phone: (574) 234-4116
Fax: (574) 234-4115
pshah@schafergear.com
www.schafergear.com

Shanghai DE Mechanical Gears Co., Ltd.
www.gearvalves.com

Shivam Autotech Ltd.
www.shivamautotech.com

Sinotech
www.sinotech.com

Sipco-MLS
www.sipco-mls.com

Siti Spa Riduttori
www.sitiriduttori.it

Snow Nabstedt Power Transmissions Inc
www.snpt.biz

Sokhi Heli-Wom Gears Pvt. Ltd.
www.gearboxindia.com

Source Engineering Inc.
www.sei-automation.com

Spencer Pettus
www.spgear.com

Spline Gauges
splinegauges.co.uk

Sprockets Australia Pty. Ltd.
www.sprocketsoz.com.au

Sterling Instrument
www.sdp-si.com

Stock Drive Products
www.sdp-si.com

Suhner Manufacturing Inc. SEE OUR AD P83
43 ANDERSON ROAD
ROME GA 30161
Phone: (706) 235-8046
Fax: (706) 235-8045
info.usa@suhner.com
www.suhner.com

Sumitomo Machinery Corp. of America
www.smcyclo.com

Supreme Gear Co.
www.supremegear.com

Suzhou Asia Pacific Metal Co., Ltd.
www.szapmc.com

T.E.A. Machine Components
www.teausa.net

Taiwan Precision Gear Corp.
www.tpg-tw.com

Taiwan United Gear Co., Ltd.
www.tugear.com.tw

Talon Machine & Gear Inc.
www.talonmachine.com

Team Industries
www.team-ind.com

Tien Yi Gear Works Co.,Ltd
www.tienyigear.com.tw

Toledo Gearmotor
www.toledogear.com

Torque Transmission
www.torquetrans.com

Transply Inc.
www.transply.com

Tristate Bearing & Supply Co. Inc.
www.tristatebearing.com

Triumph Gear Systems - Acr Industries
www.triumphgroup.com

Trojon Gear Inc.
www.trojon-gear.com

Tsubaki of Canada Limited
www.tsubaki.ca

Unigear Industries
www.unigear.com

VCST LP
www.vcst.be

VW Broaching Service Inc.
www.vwbroaching.com

Venture Products International
www.ventureproducts.com

Vision Qualitry Components, Inc
www.visionqci.com

WMH Transmissions Ltd
www.wmh-trans.co.uk

Xtek, Inc.
www.xtek.com

Yieh Chen Machinery (Six Star Group)
www.yiehchen.com

ZRIME
www.zrime.com.cn

ZZN Transmission Plant
www.zzn-transmissions.com

Zero-Max
www.zero-max.com

INDUSTRIAL HARDWARE AND MACHINE PARTS

American Plastics Depot
www.americanplasticsdepot.com

Daemar Inc.
www.daemar.com

Delta Gear Company
www.deltagearcompany.com

Designatronics, Inc. SEE OUR AD P7
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com

Gear Master Inc.
www.gearmaster.us

Hi-Grade Inc.
www.higradeinc.com

Houston Pump and Gear
www.houstonpumpandgear.com

ISC Companies
www.isccompanies.com

J.W. Winco Inc. SEE OUR AD P2
2815 S. CALHOUN ROAD
NEW BERLIN WI 53151
Phone: (800) 877-8351
sales@jwwinco.com
www.jwwinco.com

Koro Industries, Inc.
www.koroind.com

Martin Sprocket & Gear
www.martinsprocket.com

Melfast
www.melfast.com

Motion Industries
www.motionindustries.com

Netshape Technologies, Inc.
www.netshapetech.com

Nordex, Inc. SEE OUR AD P10
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com

Premier Udyog
www.premierudyog.org

SKG Enterprises
www.skgsons.com

Sterling Instrument
www.sdp-si.com

Stock Drive Products
www.sdp-si.com

LINEAR MOTION DEVICES

AGI Automation Components
www.agi-automation.com

AISCO Industrial Couplings
www.aiscoinc.com AST Bearings
www.astbearings.com

Accent Bearings Co. Inc.
www.accentbearing.com

Acorn Industrial Services
www.acorn-ind.co.uk

Advanced Control Systems Corporation
www.acsmotion.com

Aerotech Inc.
www.aerotech.com

Amacoil, Inc.
www.amacoil.com

Ametric / American Metric Corporation
www.ametric.com

Andantex USA Inc.
www.andantex.com

Area Distributors Inc.
www.areadist.com

Atlanta Drive Systems Inc.
www.atlantadrives.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Baldor Electric Company SEE OUR AD P25
5711 R.S. BOREHAM, JR. ST.
P.O. BOX 2400
FORT SMITH AR 72901
Phone: (479) 646-4711
Fax: (479) 648-5792
www.baldor.com

Beaver Aerospace and Defense Inc.
www.beaver-online.com

Bishop-Wisecarver Corp.
www.bwc.com

CUI Inc
www.cui.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Chesterfield Electric Motors
www.chesterfieldelectricmotors.com

Clarke Engineering Inc. (Clarke Gear Co.)
8058 LANKERSHIM BLVD.
NORTH HOLLYWOOD, CA 91605
Phone: (818) 768-0690
Fax: (818) 767-5577
clarkegear@earthlink.net
www.clarkegear.com
SEE OUR AD P54

Custom Gear & Machine Inc.
www.cgearinc.com

Custom Sensors & Technologies
www.cstsensors.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Davall Gears Ltd.
www.davall.com

David Brown Gear Systems
www.davidbrown.com

Del-Tron Precision Inc.
www.deltron.com

Designatronics, Inc.
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com
SEE OUR AD P7

DieQua Corp.
180 COVINGTON DRIVE
BLOOMINGDALE IL 60108
Phone: (630) 980-1133
Fax: (630) 980-1232
info@diequa.com
www.diequa.com
SEE OUR AD P12

Discovery Technology International, Inc.
www.discovtech.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

Duff Norton Australia
www.duffnorton.com.au

Duff Norton Sales South Pacific
www.dnsales.com.au

Dunkermotoren USA Inc.
www.dunkermotor.com

Durabond Slides
www.durabondslide.com

Dynamic Structures and Materials, Llc
www.dynamic-structures.com

Dynex/Rivett Inc.
www.dynexhydraulics.com

Emerson Industrial Automation - Drives & Motor
www.emersonindustrial.com

Exlar Actuation Solutions
www.exlar.com

FMC Engineering
www.fmcengineering.com

Festo Corporation
www.festo.com/usa

Framo Morat Inc.
9440 SAN MATEO BLVD NE
SUITE L
ALBUQUERQUE NM 87113
Phone: (505) 359-2949
Fax: (505) 881-2070
sales@framo-morat.com
www.framo-morat.com
SEE OUR AD P45

H2W Technologies
www.h2wtech.com

HPB Motion Control Co. Ltd.
www.hpb-industry.com

Hallmark Industries Inc.
www.hallmarkind.com

Houston Pump and Gear
www.houstonpumpandgear.com

IAI America, Inc.
www.intelligentactuator.com

IBT, Inc
www.ibtinc.com

IDA Motion Inc.
www.idamotion.com

ISC Companies
www.isccompanies.com

Industrial Clutch Parts Ltd.
www.icpltd.co.uk

Intellidrives, Inc
www.intellidrives.com

InvenSense
www.invensense.com

K+S Services
www.k-and-s.com

Kollmorgen Div. of Danaher
www.kollmorgen.com

Leeson Electric
www.leeson.com

Mavilor Motors, S.a.
www.mavilor.es

Melfast
www.melfast.com

Midwest Motion Products
www.midwestmotion.com

Mitsubishi Electric Automation, Inc.
us.mitsubishielectric.com/fa/en

Modern Linear Inc.
www.modernlinear.com

Motion Industries
www.motionindustries.com

Nordex, Inc.
426 FEDERAL ROAD
BROOKFIELD CT 06804
Phone: 203-775-4877
Fax: 203-775-6552
sales@nordex.com
www.nordex.com
SEE OUR AD P10

North American Clutch & Driveline
www.naclutch.com

Novotec Argentina SRL
www.novotecargentina.com

Ondrives Ltd
www.ondrives.com

Ormec
www.ormec.com

Orttech
www.orttech.com

PI (Physik Instrumente) L.P. Piezo Actuator Nano
www.pi-usa.us

PIC Design
www.pic-design.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Parker Hannifin SSD Drives Div.
www.parker.com/ssdusa

Performance Gear Systems, Inc.
www.performance-gear.com

Phytron, Inc.
www.phytron.com

Portescap
www.portescap.com

Precipart
www.precipart.com

Precision Screw Thread
www.precisionscrewthread.com

Precision Technologies Group (PTG) Ltd.
www.ptgltd.com

Rex Engineering Corp.
www.rex-engineering.com

Ringball Corporation
www.ringball.com

Rockwell Automation
www.rockwellautomation.com

Rowland Co., The
www.rowland2.com

SEW-Eurodrive
1295 OLD SPARTANBURG HWY.
P.O. BOX 518
LYMAN SC 29635
Phone: (864) 439-7537
Fax: (864) 439-7830
www.seweurodrive.com
SEE OUR AD INSIDE BACK COVER

SKF USA Inc.
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com
SEE OUR AD P3

SPN Schwaben Praezision
www.spn-hopf.de

Schaeffler Group USA, Inc
308 SPRINGHILL FARM ROAD
FORT MILL SC 29715
Phone: (803) 548-8500
Fax: (803) 548-8599
info.us@schaeffler.com
www.schaeffler.us
SEE OUR AD BACK COVER

Serapid Inc.
www.serapid.us

Servometer
www.servometer.com

Sesame Motor Corp.
599, SEC. 1, HEMU RD.
SHENGANG TAICHUNG 42953
TAIWAN
Phone: +(886) 4-2561-0011
Fax: +(886) 4-2562-7766
info@sesamemotor.com.tw
www.sesamemotor.com.tw
SEE OUR AD P43

Siemens Industry, Inc.
www.usa.siemens.com/industry/us/en

Sipco-MLS
www.sipco-mls.com

Steinmeyer Inc.
www.steinmeyer.com

Sterling Instrument
www.sdp-si.com

Stock Drive Products
www.sdp-si.com

Stoffel Polygon Systems, Inc.
www.stoffelpolygon.com

T.E.A. Machine Components
www.teausa.net

Tampa Armature Works- TAW
www.tawinc.com

Technico
www.technico.com

Tecnotion BV
www.tecnotion.com

TelcoMotion
www.telcointercon.com

Thomson Div. of Danaher
www.thomsonlinear.com

Tolomatic, Inc.
www.tolomatic.com

Tristate Bearing & Supply Co. Inc.
www.tristatebearing.com

VL Motion Systems Inc.
www.vlmotion.com

WEG
www.weg.net

WMH Transmissions Ltd
www.wmh-trans.co.uk

Warner Linear
www.warnerlinear.com

Whittet-Higgins Company
www.whittet-higgins.com

Wittenstein
www.wittenstein-us.com

Yaskawa America, Inc.
www.yaskawa.com

LUBRICATION

Acorn Industrial Services
www.acorn-ind.co.uk

Daubert Cromwell LLC
www.daubertcromwell.com

Filter Pumper / Hydraulic Problems, Inc.
www.filterpumper.com

Houghton International Inc.
www.houghtonintl.com

ISC Companies
www.isccompanies.com

Isel Inc.
www.iselinc.com

Lubriplate Lubricants Co. SEE OUR AD P29
129 LOCKWOOD STREET
NEWARK NJ 07105
Phone: (800) 733-4755
Fax: (973) 589-4432
www.lubriplate.com

SKF USA Inc. SEE OUR AD P3
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com

Schaeffler Group USA, Inc SEE OUR AD BACK COVER
308 SPRINGHILL FARM ROAD
FORT MILL SC 29715
Phone: (803) 548-8500
Fax: (803) 548-8599
info.us@schaeffler.com
www.schaeffler.us

Tristate Bearing & Supply Co. Inc.
www.tristatebearing.com

MOTORS

ASI Technologies Inc.
www.asidrives.com

Accent Bearings Co. Inc.
www.accentbearing.com

Acorn Industrial Services
www.acorn-ind.co.uk

Advanced Control Systems Corporation
www.acsmotion.com

Aerotech Inc.
www.aerotech.com

Allied Motion
www.alliedmotion.com

Ametric / American Metric Corporation
www.ametric.com

Applied Dynamics
www.applied-dynamics.com

Arc Systems, Inc
www.arcsystemsinc.com

Area Distributors Inc.
www.areadist.com

Automation Direct SEE OUR AD INSIDE FRONT COVER
3505 HUTCHINSON ROAD
CUMMING GA 30040
Phone: (800) 633-0405
Fax: (770) 889-7876
sales@automationdirect.com
www.automationdirect.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Baldor Electric Company SEE OUR AD P25
5711 R.S. BOREHAM, JR. ST.
P.O. BOX 2400
FORT SMITH AR 72901
Phone: (479) 646-4711
Fax: (479) 648-5792
www.baldor.com

Bison Gear and Engineering Corp.
www.bisongear.com

Bodine Electric Company
www.bodine-electric.com

Bonfiglioli Riduttori S.p.A.
www.bonfiglioli.com

Bonfiglioli USA
www.BonfiglioliUSA.com

Boston Gear
www.bostongear.com

Buehler Motor, Inc.
www.buehlermotor.com

Chesterfield Electric Motors
www.chesterfieldelectricmotors.com

Cone Drive
www.conedrive.com

Conroll Corporation
www.conroll.com

Custom Motors Inc.
www.custommotorsmn.com

Custom Sensors & Technologies
www.cstsensors.com

Cutes Corporation
www.cutes.com.tw

Dalton Bearing Service, Inc.
www.daltonbearing.com

Davall Gears Ltd.
www.davall.com

David Brown Gear Systems
www.davidbrown.com

Designatronics, Inc. SEE OUR AD P7
2101 JERICHO TURNPIKE
NEW HYDE PARK NY 11040
Phone: (516) 328-3300
Fax: (516) 326-8827
info@designatronics.com
www.designatronics.com

DieQua Corp. SEE OUR AD P12
180 COVINGTON DRIVE
BLOOMINGDALE IL 60108
Phone: (630) 980-1133
Fax: (630) 980-1232
info@diequa.com
www.diequa.com

Discovery Technology International, Inc.
www.discovtech.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

Duff Norton Australia
www.duffnorton.com.au

Dunkermotoren USA Inc.
www.dunkermotor.com

Dynex/Rivett Inc.
www.dynexhydraulics.com

Electro Static Technology
www.est-aegis.com

Electronic Machine Parts
www.empregister.com

Elektrim Motors
www.elektrimmotors.com

Emerson Industrial Automation - Drives & Motor
www.emersonindustrial.com

Exlar Actuation Solutions
www.exlar.com

Festo Corporation
www.festo.com/usa

Foshan Xingguang Transmission Machinery Co. Ltd.
www.xg-cd.cn

Framo Morat Inc. SEE OUR AD P45
9440 SAN MATEO BLVD NE
SUITE L
ALBUQUERQUE NM 87113
Phone: (505) 359-2949
Fax: (505) 881-2070
sales@framo-morat.com
www.framo-morat.com

GMB Associates
www.gmbassociates.co.uk

Groschopp Inc.
www.groschopp.com

H2W Technologies
www.h2wtech.com

HPB Motion Control Co. Ltd.
www.hpb-industry.com

Hallmark Industries Inc.
www.hallmarkind.com

Hansen Corporation
www.hansen-motor.com

Hoffmann Technics AG
www.hoffmann-tech.ch

IBT, Inc
www.ibtinc.com

ISC Companies
www.isccompanies.com

Intellidrives, Inc
www.intellidrives.com

JVL Industri Elektronik A/S
www.jvl.dk

K+S Services
www.k-and-s.com

Kollmorgen Div. of Danaher
www.kollmorgen.com

Lafert North America SEE OUR AD P13
5620 KENNEDY RD.
MISSISSAUGA ON L4Z 2A9
CANADA
Phone: (905) 629-1939 or
toll free (800) 661-6413
Fax: (905) 629-2852
sales@lafertna.com
www.lafertna.com

Leeson Electric
www.leeson.com

MT Tool & Manufacturing
www.ourmachinist.com

Mark Elektriks
www.markelektriks.com

Mavilor Motors, S.a.
www.mavilor.es

Maxon Precision Motors Inc
www.maxonmotorusa.com

Midwest Motion Products
www.midwestmotion.com

Mitsubishi Electric Automation, Inc.
us.mitsubishielectric.com/fa/en

Motion Industries
www.motionindustries.com

Navyug Electric Motors & Pumps Ltd
www.navyugelectricmotors.com

New Power Electric (USA) LLC
www.usa-newpower.com

Ningbo Zhongyi Hydraulic Motor Co. Ltd.
www.zihyd.com

Norwin Electronics Limited
www.norwin.co.uk

Novotec Argentina SRL
www.novotecargentina.com

Onvio LLC
www.onviollc.com

Ormec
www.ormec.com

PI (Physik Instrumente) L.P. Piezo Actuator Nano
www.pi-usa.us

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Parker Hannifin - SSD Drives Div.
www.ssddrives.com

Parker Hannifin SSD Drives Div.
www.parker.com/ssdusa

Performance Gear Systems, Inc.
www.performance-gear.com

Phytron, Inc.
www.phytron.com

Popular Mechanical Works
www.popularmechworks.com

Portescap
www.portescap.com

Precision Microdrives Limited
www.precisionmicrodrives.com

Rae DC Products Group
www.raemotors.com

Regal Power Transmission Solutions
www.regalpts.com

Rex Engineering Corp.
www.rex-engineering.com

Rockwell Automation
www.rockwellautomation.com

SEW-Eurodrive — SEE OUR AD INSIDE BACK COVER
1295 OLD SPARTANBURG HWY.
P.O. BOX 518
LYMAN SC 29635
Phone: (864) 439-7537
Fax: (864) 439-7830
www.seweurodrive.com

SKF USA Inc. — SEE OUR AD P3
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com

Schaeffler Group USA, Inc — SEE OUR AD BACK COVER
308 SPRINGHILL FARM ROAD
FORT MILL SC 29715
Phone: (803) 548-8500
Fax: (803) 548-8599
info.us@schaeffler.com
www.schaeffler.us

Schneider Electric Motion USA
motion.schneider-electric.com

Sesame Motor Corp. — SEE OUR AD P43
599, SEC. 1, HEMU RD.
SHENGANG TAICHUNG 42953
TAIWAN
Phone: +(886) 4-2561-0011
Fax: +(886) 4-2562-7766
info@sesamemotor.com.tw
www.sesamemotor.com.tw

Siemens Energy & Automation
www.sea.siemens.com

Siemens Industry, Inc.
www.usa.siemens.com/industry/us/en

Sinotech
www.sinotech.com

Sipco-MLS
www.sipco-mls.com

Siti Spa Riduttori
www.sitiriduttori.it

Source Engineering Inc.
www.sei-automation.com

Star Gears
www.stargears.in

Stock Drive Products
www.sdp-si.com

Sumitomo Machinery Corp. of America
www.smcyclo.com

TSS Rotterdam B.V.
www.tssr.nl

TVT America, Inc.
www.tvtamerica.com

Taiwan Precision Gear Corp.
www.tpg-tw.com

Taiwan United Gear Co., Ltd.
www.tugear.com.tw

Tampa Armature Works- TAW
www.tawinc.com

Techtop Industries, Inc.
www.techtopind.com

Tecnotion BV
www.tecnotion.com

Teco Westinghouse
www.tecowestinghouse.com

Tef - Cap Industries
www.TefCap.com

TelcoMotion
www.telcointercon.com

Thomson Div. of Danaher
www.thomsonlinear.com

Tien Yi Gear Works Co.,Ltd
www.tienyigear.com.tw

Tolomatic, Inc.
www.tolomatic.com

Transply Inc.
www.transply.com

VL Motion Systems Inc.
www.vlmotion.com

WEG
www.weg.net

Wittenstein
www.wittenstein-us.com

WorldWide Electric
www.worldwideelectric.net

Yaskawa America, Inc.
www.yaskawa.com

Yilmaz Reduktor Sanayi ve Tic A.S.
www.yr.com.tr

Zhengzhou AOKMAN Machinery Co. Ltd.
www.aokman-gearbox.com

RESOURCES

AGMA
www.agma.org

Beyta Gear Service — SEE OUR AD P83
0N230 COUNTY FARM ROAD
WINFIELD, IL 60190
chuck@beytagear.com
www.beytagear.com

Deutsche Messe AG
www.messe.de

Industrial Careers Pathway (ICP)
www.ptda.org

Lafert North America — SEE OUR AD P13
5620 KENNEDY RD.
MISSISSAUGA ON L4Z 2A9
CANADA
Phone: (905) 629-1939 or
toll free (800) 661-6413
Fax: (905) 629-2852
sales@lafertna.com
www.lafertna.com

PTDA
www.ptda.org

Randall Publications LLC
www.powertransmission.com

SEALS

Accent Bearings Co. Inc.
www.accentbearing.com

Acorn Industrial Services
www.acorn-ind.co.uk

Ametric / American Metric Corporation
www.ametric.com

Applied Dynamics
www.applied-dynamics.com

Area Distributors Inc.
www.areadist.com

BDI - Bearing Distributors Inc.
www.bdi-usa.com

Bearing Service Company
www.bearing-service.com

Centritec Seals, LLC
www.centritecseals.com

Certified Reducer Rebuilders Inc
www.certifiedreducer.net

Core Supply LLC
www.coresupplyllc.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Darbar Belting
www.darbarbelting.co.in

GMN Bearing USA, Ltd.
www.gmnbt.com

Houston Pump and Gear
www.houstonpumpandgear.com

IBT, Inc
www.ibtinc.com

IDC Select
www.IDCselect.com

ISC Companies
www.isccompanies.com

J.W. Winco Inc. — SEE OUR AD P2
2815 S. CALHOUN ROAD
NEW BERLIN WI 53151
Phone: (800) 877-8351
sales@jwwinco.com
www.jwwinco.com

Koro Industries, Inc.
www.koroind.com

MROSupply
www.mrosupply.com

Motion Industries
www.motionindustries.com

Moventas Ltd.
www.moventas.com

PTD Outlet: Power Transmission Distributors
www.ptdoutlet.com

Rubena a.s.
www.rubena.cz

SKF USA Inc. — SEE OUR AD P3
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com

Smalley Steel Ring Company — SEE OUR AD P15
555 OAKWOOD ROAD
LAKE ZURICH IL 60047
Phone: (847) 719-5900
Fax: (847) 719-5999
info@smalley.com
www.smalley.com

Zerelli Technologies Inc
www.zerelli.com

SENSORS

Acorn Industrial Services
www.acorn-ind.co.uk

Akron Gear and Engineering
www.akrongear.com

Allied Motion
www.alliedmotion.com

AmTech International
www.amtechinternational.com

Applied Dynamics
www.applied-dynamics.com

Area Distributors Inc.
www.areadist.com

Automation Direct SEE OUR AD INSIDE FRONT COVER
3505 HUTCHINSON ROAD
CUMMING GA 30040
Phone: (800) 633-0405
Fax: (770) 889-7876
sales@automationdirect.com
www.automationdirect.com

Axu s.r.l.
www.axu.it/en

BDI - Bearing Distributors Inc.
www.bdi-usa.com

BEI Sensors
www.beisensors.com

Binsfeld Engineering
www.binsfeld.com

Binsfeld Engineering Inc.
www.binsfeld.com

Bison Gear and Engineering Corp.
www.bisongear.com

CUI Inc
www.cui.com

Conroll Corporation
www.conroll.com

Custom Sensors & Technologies
www.cstsensors.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

Duff Norton Australia
www.duffnorton.com.au

Dunkermotoren USA Inc.
www.dunkermotor.com

Electronic Machine Parts
www.empregister.com

FSI Technologies Inc.
www.fsinet.com

Fagor Automation
www.fagor-automation.com

Festo Corporation
www.festo.com/usa

GMB Associates
www.gmbassociates.co.uk

GP:50 Corporation
www.GP50.com

HBM
www.hbm.com

HPB Motion Control Co. Ltd.
www.hpb-industry.com

Heidenhain Corporation
www.heidenhain.com

Hitec Sensor Solutions
www.hitecorp.com

IBT, Inc
www.ibtinc.com

ISC Companies
www.isccompanies.com

Industrial Clutch Parts Ltd.
www.icpltd.co.uk

Intellidrives, Inc
www.intellidrives.com

InvenSense
www.invensense.com

JVL Industri Elektronik A/S
www.jvl.dk

K+S Services
www.k-and-s.com

Kavlico Corporation
www.kavlico.com

Magtrol, Inc.
www.magtrol.com

Marshall Wolf Automation Inc.
www.wolfautomation.com

Maxcess
www.maxcessintl.com

Maxon Precision Motors Inc
www.maxonmotorusa.com

Mayr Corporation
www.mayrcorp.com

Micronor Inc.
www.micronor.com

Midwest Motion Products
www.midwestmotion.com

Motion Industries
www.motionindustries.com

Norwin Electronics Limited
www.norwin.co.uk

Novotec Argentina SRL
www.novotecargentina.com

PI (Physik Instrumente) L.P. Piezo Actuator Nano
www.pi-usa.us

Portescap
www.portescap.com

Potomac Electric
www.potomacelectric.com/

Precipart
www.precipart.com

RDF Corporation
www.rdfcorp.com

Rockwell Automation
www.rockwellautomation.com

Rowland Co., The
www.rowland2.com

SKF USA Inc. SEE OUR AD P3
890 FORTY FOOT ROAD
LANSDALE PA 19446
Phone: (267) 436-6000
Fax: (267) 436-6001
www.skf.com

Schenck Trebel Corporation
www.schenck-usa.com

Sensor Developments, Inc
www.sendev.com

Sensor Products Inc.
www.sensorprod.com

Sensor Technology Ltd
www.sensors.co.uk

Sinotech
www.sinotech.com

Source Engineering Inc.
www.sei-automation.com

Stellar Technology, Inc.
www.stellartech.com

Tef - Cap Industries
www.TefCap.com

Transply Inc.
www.transply.com

Xtek, Inc.
www.xtek.com

SOFTWARE

Excel Gear, Inc. SEE OUR AD P14
11865 MAIN STREET
ROSCOE IL 61073
Phone: 815-623-3414
Fax: 815-623-3314
chinn@excelgear.com
www.excelgear.com

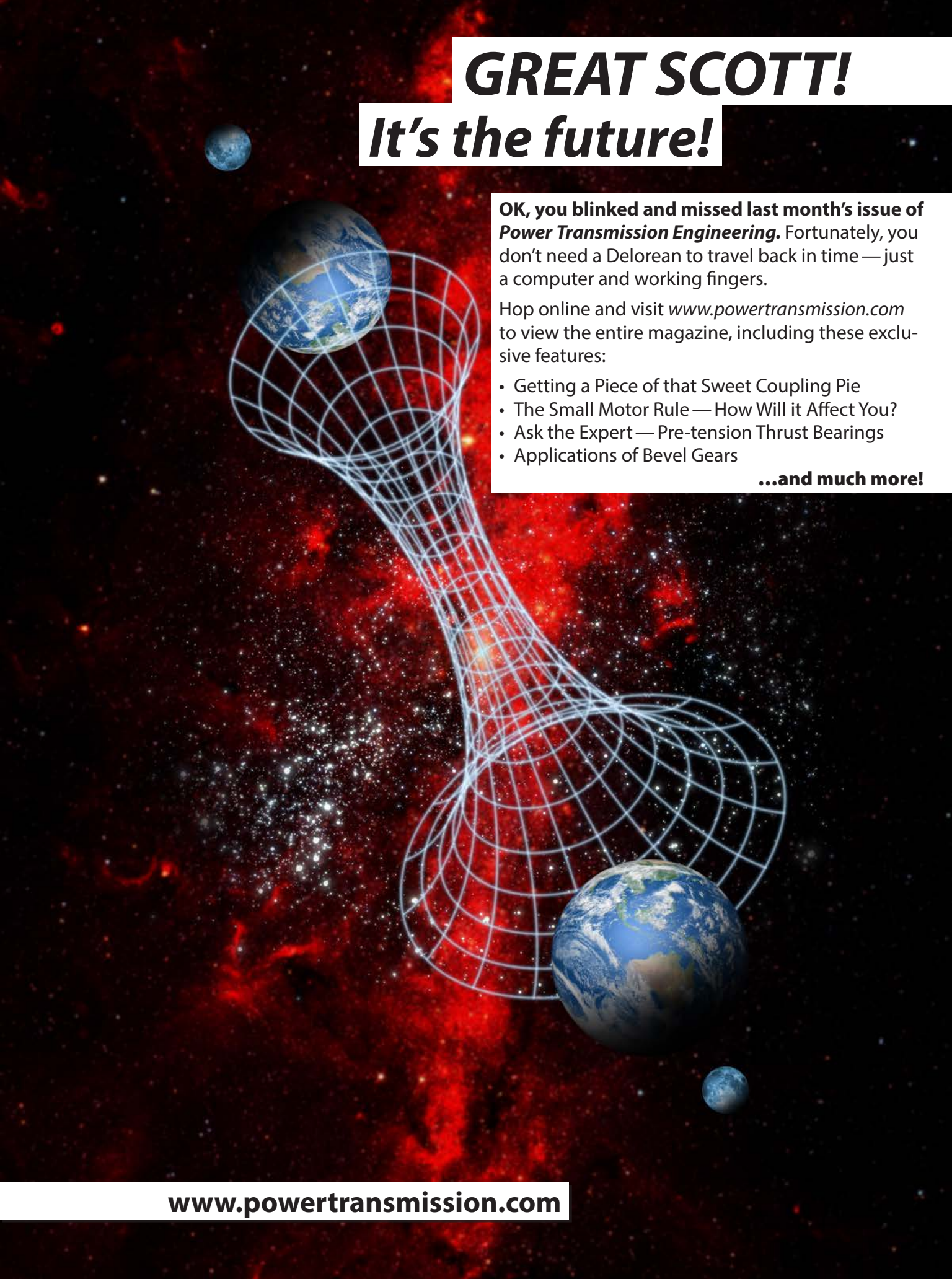
Involute Simulation Software Inc.
www.hygears.com

MESYS AG
www.mesys.ch

Mark Elektriks
www.markelektriks.com

Qualtira
www.productselectionpro.com

ZRIME
www.zrime.com.cn



GREAT SCOTT!
It's the future!

OK, you blinked and missed last month's issue of *Power Transmission Engineering.* Fortunately, you don't need a Delorean to travel back in time — just a computer and working fingers.

Hop online and visit *www.powertransmission.com* to view the entire magazine, including these exclusive features:

- Getting a Piece of that Sweet Coupling Pie
- The Small Motor Rule — How Will it Affect You?
- Ask the Expert — Pre-tension Thrust Bearings
- Applications of Bevel Gears

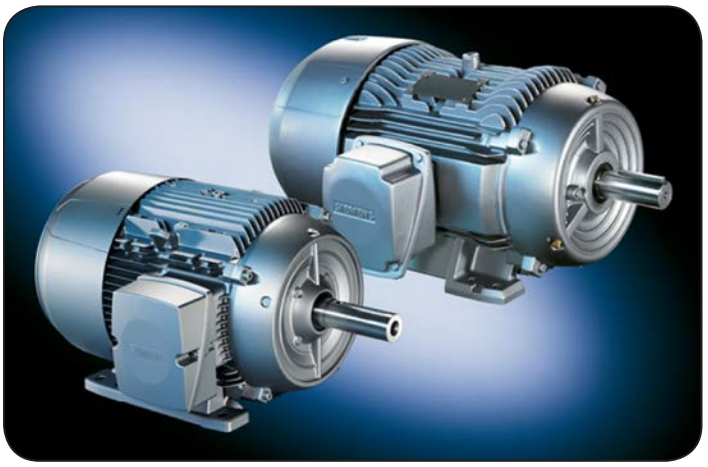
...and much more!

www.powertransmission.com

Motor Management — Best Practices

Part II: Motor Failure Policies and Purchasing Specifications

Reprinted with kind permission of Copper Development Association Inc.



Energy costs and downtime can be greatly reduced by instituting a motor management plan. Part II of this three-part series specifically addresses the establishment of a motor failure policy and the development of purchasing specifications. Part I addressed the general aspects of a motor management plan, including the first steps of creating a motor inventory and guidelines for motor repair and replacement. Part III will examine motor repair specifications as well as preventive and predictive maintenance.

Introduction

As described in Part I, a motor management plan needs to be instituted at the facility level to be effective. Lacking such a plan, invisible and uncontrolled costs from excess energy use, frequent downtime and productivity losses can become significant.

The keystone of any plan is the assessment of the motor population of the facility, both for in service and in spares motors. There would be no clarity for acting on any plan or measuring its effectiveness without a proper motor inventory. Part I outlined a basic plan for taking inventory of the motors; creating guidelines for replacing and repairing them; and gaining management support through the demonstration of financial incentives.

Part II goes beyond the basic plan and details the specifications for purchasing motors; it describes sound policies that can be adopted to guide investments in new and replacement motors.

The final installment — Part III — will address proper motor repair specifications, as well as preventative and predictive maintenance.

Motor Failure Policy

Ideally, worn out motors would be replaced before they fail and interrupt production. A motor failure policy is a set of guidelines and supporting infrastructure that enables decisive and proper action to take place. It is established before a motor failure occurs.

Using the repair-and-replace guidelines presented in Part I, one can begin to develop a meaningful motor failure policy. Motor failure policy comes down to these choices: *repair* this motor at failure; *replace* it at failure; or *retrofit* it immediately.

Motor Decisions Matter periodically publishes a compilation of motor planning resources. For the most up-to-date resource list, refer to the "Motor Planning Kit" section on the Motor Decisions Matter website at *www.motorsmatter.org*. The same website offers the process flow chart titled "Motor System Management Plan" presented here.

Critical Motors

It is essential to identify the critical motors in your facility; i.e. — these motors are the most important to your business process. Their failure would cause a financial setback or a lost opportunity.

Contingency plans should be proactively developed so if one of these critical motors fails, the problem can be quickly resolved and any effect on production is minimized.

Kitt Butler, director, Motors & Drives, Advanced Energy Corporation, Raleigh, North Carolina, says, "You want to identify the critical motors in your process. If one motor in the middle of the line fails, then the whole mill could go down. You cannot just wait for that to happen; you have to have a plan ready before that motor fails. That is the crux of motor management: plan before the motor fails. If you allow the motor to fail before determining what to do, then you will typically be in panic mode and bad things can happen."

If the plan for a particular motor is to repair or rewind upon failure, make certain to select a service center that adheres to guidelines established by the Electrical Apparatus Service Association (EASA); (see *www.easa.com/energy* for more information).

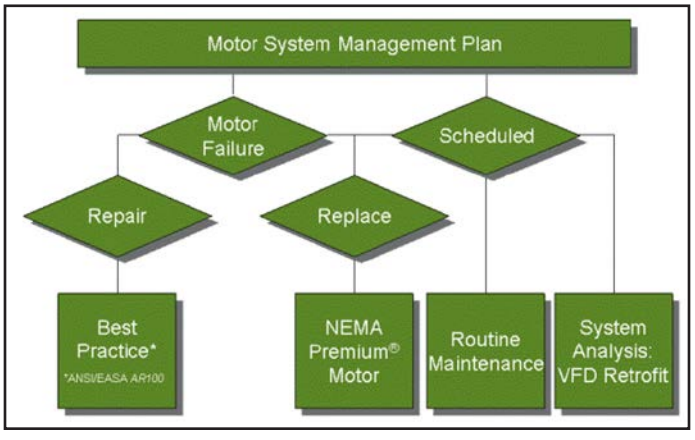


Figure 1 A motor management plan needs to be instituted at the facility level to be effective.

Motor Spares Inventory

To address downtime, motor failure policy must define a motor spares inventory; it must support actions that minimize costly business interruptions. According to Butler, "A spare motor inventory is indispensable in motor management — especially for critical motors. Spares need to be within arm's reach, should an in-service motor go down."

A spares inventory program should align with plans to upgrade motors to NEMA Premium efficiency. Upgrade spares as well as operating motors; replacing a failed older, less-efficient motor with another standard efficiency motor provides no energy savings or operating cost reduction.

Johnny Douglass, retired senior industrial engineer, Washington State University Energy Program, says, "The spares inventory includes motors that fit more than one application; quite often motors in the one-to-100 horsepower range can fit into a variety of locations. Consequently, the spares inventory should consist of NEMA Premium motors; the fact that a motor in spares may go many places dictates that all the motors should be NEMA Premium motors."

MotorMaster+ inventory lists are useful for sharing with motor distributors. If you can't stock some motors at your facility because of lack of budget or storage space, you can share in-service motor inventory lists with your distributor and ask the distributor to stock those NEMA Premium motors on your list. In this manner spare motors are available on short notice, but stored elsewhere.

(**Note**: The DOE (U.S. Dept. of Energy) *MotorMaster+* software is free to U.S. addresses, and can be obtained at: *www1.eere.energy.gov/manufacturing/ tech_deployment/software_motormaster.html*.)

There are other financial limitations to a motor spares inventory; for example, very large motors can be expensive to store. Scheduled monitoring of such large motors gives advanced warning; such monitoring allows sufficient lead times to order a new motor or arrange for a motor to be rewound during scheduled downtime.

As the purchasing agent for Qubica/AMF, Rick Streeter has overseen the upgrade of motor spares and knows of the above limitations. "I try to have a spare motor for every machine whenever possible, but some of our motors are just too big to keep in spares here on-site. For example, we use 150 and 200 horsepower motors that are just too big to keep in spares. On the other hand, for the smaller motors I keep at least one spare on hand for every type of motor that we use here."

Repair or Replace?

Horsepower breakpoint. In part I of this series (October *PTE*), horsepower breakpoint was covered in the context of the repair-or-replace decision. It is also a consideration in motor failure policy. The policy can be as elementary as "always replace motors under 50 horsepower" — or more sophisticated.

Useful graphs (courtesy Advanced Energy Corporation) for picking a horsepower breakpoint can be created using special calculators. In one such graph, the vertical axis represents motor horsepower and the other axis represents hours of operation. The calculator plots a curve that depends on the cost of electricity. Once a curve is plotted it is easy to find the horsepower breakpoint that corresponds to any payback period of operation. (Note: Tools for calculating the horsepower breakpoint are available on the Advanced Energy website; also see the "Horsepower Bulletin" @ *www.advancedenergy.org/md/knowledge_library/resources/Horsepower%20Bulletin.pdf*).

Butler points out, "Surveying all the motors in a facility can be labor intensive. It takes eyeballs and legs. One has to walk around and look at all the nameplates of the motors, recording and processing all that information."

Replace at failure. Motors should be tagged for replacement upon failure. Gilbert McCoy, P.E., energy systems engineer with the Washington State University (WSU) Energy Office, Olympia, Washington, advises, "Use *MotorMaster+* to calculate the energy savings for each motor in your plant. Fortunately, *MotorMaster+* can accomplish this for all the motors in the inventory with one quick batch analysis. Tag those motors that should be replaced upon failure so the millwrights know what to do, and which spare motors should be NEMA Premium motors versus older standard motors."

Opportunities for energy savings are lost when spare motors are not properly tagged. "The millwrights are likely to pick an old standard efficiency motor and install it," McCoy points out. "At that point, the opportunity is lost for energy savings throughout that motor's operating life — which could be ten years or more."

More Recommendations

Frequent failures first. Some industries kick off their motor improvement project by identifying motors with histories of frequent failure. Obviously, besides replacing the motors it is also prudent to identify and correct the root cause of the problem. EASA has developed an in-depth seminar and reference manual on "Root Cause Failure Analysis," according to Tom Bishop, P.E., senior technical support specialist for the EASA, St. Louis, Missouri.

If the cause of failure is due to a harsh environment, then you can reduce downtime and increase reliability — while also realizing significant energy savings — by replacing those problem motors either with premium-efficiency motors or premium efficiency, severe-duty motors.

The Longview complex of the Weyerhaeuser Company in Longview, Washington serves as an excellent example. It instituted a policy calling for all non-IEEE 841 motors of 50 horsepower or less to be replaced upon failure with energy-efficient IEEE 841-2001 models — regardless of condition, age or rebuild history of the existing motor.

McCoy recalls, "A few years ago we had the opportunity to work with a Weyerhaeuser pulp and paper mill. A review of the maintenance records showed 28 motors with histories of frequent failures; these motors would fail every two to four years, resulting in downtime and lost productivity. The company jump-started its motor improvement program by immediately replacing problem motors with new NEMA Premium efficiency motors. It chose not only premium efficiency motors but also NEMA Premium efficiency IEEE-841

petroleum and chemical duty motors. Some manufacturers call these motors "extra tough" or "severe duty" motors; in addition to an expected longer operating life and long warranties, these motors are corrosion-resistant and have lower vibration displacements."

(A case study on the Weyerhaeuser motor failure policy can be found in the electrical applications section of the CDA website: *www.copper.org/environment/sustainable-energy/transformers/education/archive/weyerhaeuser.html.*)

Monitor the spares. Spare motors are supposed to be ready to replace failed, in-service motors. But how ready are they? If the spares are not premium efficiency motors, then you may be better off recycling them, depending also on factors such as hours of operation. If they are NEMA Premium motors, then they need occasional shaft rotation to avoid "flat-spotting" — as do all motors sitting in storage.

As Douglass notes, "A motor upgrade program must address spares as well as operating motors. Sometimes spare motors of standard efficiency should be recycled — even if freshly rewound. You may be able to recover some of the cost from the motor components inside."

Failed EPAct motors. The decision to scrap failed EPAct motors and replace them with new NEMA Premium motors should be based on a lifecycle analysis. EPAct motors are less efficient than NEMA Premium motors, and no energy savings are realized by putting an EPAct motor back in service. A rewound motor could be even less efficient than when it was new; however, a service center that adheres to EASA good practice guidelines should be able to mitigate or resolve efficiency losses. For more information on good practices, visit the EASA website (*www.easa.com/energy*).

McCoy contends, "When we do our motor assessments, we look mainly at replacing standard-efficiency motors — when they fail — with NEMA Premium efficiency motors. Nonetheless, depending on operating hours and utility rates, many times it is also cost-effective to junk EPAct efficiency motors when they fail and replace them with new NEMA Premium efficiency motors." Standardizing on T-frame motors also reduces the number of motors that must be maintained in the on-site spares inventory.

Oversized motors. Research shows that the efficiency of most motors peaks for loads between 70 – 75 percent, and declines below 50 percent. The situation is different for large motors, however, according to McCoy. "Motor assessment staff generally believe oversized, under-loaded motors are bad," he says. "They recommend replacing motors loaded to less than 50 percent of their full load with smaller motors matching load requirements. But large, standard efficiency motors should not be replaced with smaller, standard efficiency motors. The energy savings will be small or non-existent because larger motors typically have higher, full-load and part-load efficiencies than smaller motors. Large motors generally maintain a high efficiency all the way down to 25 percent of load. The benefit comes from replacing oversized motors with a smaller premium efficiency motor matched to load requirements."

Bishop summarizes, "Efficiency may be higher for larger motors than for smaller motors, but it is still reduced when not matched to the load."

Minimize downtime with severe-duty motors. The true cost of downtime is difficult to calculate and often underestimated. Downtime is the subject of countless process improvement projects within a typical company — which speaks to its importance. A plant typically loses several percent of its production capacity because of downtime; and most plants do not calculate downtime costs accurately, underestimating the total cost by 200 or even 300 percent.

Bruce Benkhart, director, Advanced Proactive Technologies, Springfield, Massachusetts adds, "Downtime is crucial to any facility, whether an office, a hospital, or an industrial plant. Whether they are making widgets, cars or pharmaceuticals, downtime means that production stops and profits plummet. Downtime is ultimately the most important consideration."

McCoy gathered data on the cost of downtime at a pulp mill in British Columbia. "Downtime is critical for industrial plants," he says. "This pulp mill had a capacity of about 1,100 air-dried-metric-tons-per-day. We calculated the value of the pulp produced at $25,000-per-hour at a price of $600-per-ton. In the case of this pulp mill, the cost of downtime is huge. The reliability and uptime benefits from new premium efficiency motors can dwarf the energy costs. To realize these benefits, motor managers in the mills and process industries preferentially purchase "severe-duty" motors — or IEEE-841 petroleum and chemical duty motors.

"In a severe processing environment, replacing existing motors with NEMA Premium severe-duty motors makes good business sense, especially when downtime is critical," says Bishop, "but a severe-duty motor in a non-severe duty application probably won't save more energy than other motors of the same efficiency."

Frame adapters. Adapter rails and bases have been available for decades. They are used to install T-frame motors in systems designed for older U-frame motors.

Motor interchangeability is common today because of the standardization of frame sizes. Motors of the same horse power, speed and enclosure normally fit the same frame size, even though the motors are from different manufacturers. In other words, if the motors are in standard frame sizes, then a motor from one manufacturer is interchangeable with a similar motor from another.

Yet, in some situations, the frame sizes are not the same. Motors have become more compact for a given horsepower, primarily due to better insulation (Class H at 180° C) that allows motors to run much hotter in a smaller package (T-frame). What do you do when you find a motor of the older U-frame type in your facility?

Regarding frame sizes, McCoy comments, "Motor manufacturers make premium efficiency U-frame motors, but such motors carry a considerable cost-adder. When we see old U-frame motors in a plant, we know they are likely to be repaired when they fail. They are often returned to service because the mounting bolts and shaft heights for those motors are different than those of a T-frame motor. Nonetheless, we encourage the purchase of frame adapters or transition bases, which ideally would be maintained in the spares

warehouse and readily available when an old U-frame motor fails. In this manner the old motor can be easily replaced with a modern T-frame motor."

Purchasing Specifications

Purchasing specifications cover a wide gamut of elements; they identify and specify what motors to stock and how many, and they document the decision-making process. The following sections outline some key considerations relating to the development of purchasing specifications.

Develop corporate support. Organizationally, energy efficiency management tends to be a fractured process. A disconnect often occurs between plant maintenance, engineering, purchasing and finance. Cooperation needs to evolve into teamwork before advances in energy savings can happen.

Rob Penney offers some insights on organization; he is senior energy engineer for the Washington State University Energy Program, as well as a professional mechanical engineer and certified energy manager. He is responsible for the energy savings team, business development and energy project deliverables at WSU. "Within a business, purchasing makes motor purchases, accounting pays the energy bill, and engineering looks at the process," he says. "They often do not communicate effectively with each other. Only when each pays attention to the motor systems, and they all work together as a team, can they bring it all together, making good motor management decisions and really saving energy." The team approach lends itself nicely to gaining corporate support.

Official mandates. Butler at Advanced Energy reminds, "EISA was signed into law by George Bush in 2007. It covers many energy-related topics, including motors, and became effective December 2010. For general purpose motors from one horsepower to 200 horsepower, EISA raised mandated efficiency levels above the levels of EPAct legislation of 1992." (See Table 1 for comparison of EPAct to EISA efficiencies at various horsepower.)

Butler continues, "The Department of Energy is mandated by Congress to expand the efficiency envelope for electric motors. It has done so since 1992 without using exotic materials and designs, but it is reaching a point of diminishing returns. Meanwhile, the industry, efficiency advocates, and other stakeholders are recommending to the DOE that it consider motors not previously covered; for example, motors with mechanical alterations that do not affect motor efficiency. Gear motors are a good example."

Prior to EISA, OEMs were motivated mainly by cost and reliability; efficiency wasn't a high priority. But now that has changed. Emmanuel Agamloh, Ph.D., P.E., motor systems engineer for Advanced Energy, says "We hear a lot about efficiency now. OEMs are paying attention to the efficiency of their motors in their equipment. The EISA legislation is playing a vital role because the increase from EPAct to NEMA Premium efficiency levels directly affects the choice of motors by equipment manufacturers. At Advanced Energy we often receive requests from OEMs to verify that electric motors meet the EISA efficiency levels so they can be put in the OEM equipment."

Even higher efficiency. Some motor technologies provide even higher efficiencies than NEMA Premium; referring to the CDA's technical reference library, induction motor engineers have long known that replacing die-cast aluminum with copper in the rotor squirrel cage reduces motor losses by as much as 15 – 20 percent — thereby improving energy efficiency.

Meanwhile, motor manufacturers have improved on copper rotor technology to the point that copper-rotor motors often exceed the NEMA Premium efficiency standard by a few percentage points (Fig. 2).

As McCoy points out, "The highest standard for motor efficiency is designated NEMA Premium; yet some motors built with advanced technology exceed that standard by at least a fraction of a percentage point or even by a few percentage points. Those motors are often built with cast copper in the rotor, or permanent magnets in the rotor for motors operated exclusively with variable frequency drives."

The advantages of permanent magnets might not be realized with smaller motors.

MotorMaster+ includes an embedded, motor-manufacturer inventory of 17,000 motors, along with a price-and-performance database. The program allows search results of motors to be listed in descending order of full-load efficiency.

McCoy says, "Below twenty horsepower, copper-rotor motors are likely to be at the top of the energy listing."

Discounts and incentives. Pay attention to discounts as you make payback calculations; they can be significant. Look for discounts from your distributor. List prices are merely starting points for price negotiation. Take advantage of volume purchases and any available energy program rebates.

"The catalogues and websites of motor distributors give the list price for each motor," McCoy says. "The truth is that manufacturers seldom sell motors at list price and often of-

Table 1 Comparison of NEMA Premium to Energy Efficient motor efficiencies at different horsepower

Hz	NEMA Premium®	Energy Efficient
1	85.5	82.5
1.5	86.5	84.0
2	86.5	84.0
3	89.5	86.5
5	89.5	87.5
7.5	91.7	89.5
10	91.7	89.5
15	92.4	91.0
20	93.0	91.0
25	93.6	91.7
30	93.6	92.4
40	94.1	93.0
50	94.5	93.6
60	95.0	94.1
75	95.4	94.1
100	95.4	94.5
125	95.4	95.0
150	95.8	95.0
200	96.2	95.4
250	96.2	95.4
300	96.2	95.4
350	96.2	95.4
400	96.2	95.4
450	96.2	95.8
500	96.2	95.8

Table values are for 1800RPM TEFC motor, Efficiency values for other speeds and enclosures are available at www.advancedenergy org/md/knowledge_library/hp_breakpoint_tool/

fer discounts. The more motors an industry buys, the bigger the discount they are likely to get. If I were to place a large order directly with a motor manufacturer, I might then enjoy a discount as big as 65 percent off the list price. Typically, large industries achieve discounts of about 50 percent from their local distributor."

Terry Blodgett, branch manager (retired), Kaman Industrial Technologies, Watertown, New York says, "The price of a motor depends on the quantity ordered at one time. Buying one at a time versus several at a time has a significant impact. You could replace your motors one at a time, but if you buy in multiples the discount will be much greater, and you will have much more buying power to develop a much stronger

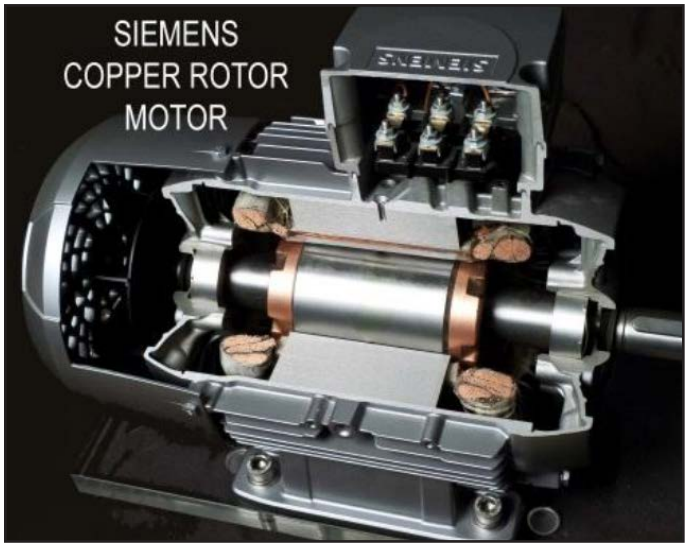


Figure 2 Below 20 hp, copper-rotor motors are likely to be at the top of the energy listing.

price if you buy plant-wide. The lower the price, the shorter the payback period."

Incentive programs provide additional savings. State programs may provide financial incentive to assist end users in purchasing energy efficient products.

NYSERDA (New York State Energy Research and Development Authority) supported an incentive program in New York State for many years. Benkhart says, "Applied Proactive Technologies has been running the NYSERDA motors program since 2002. Originally, the premium efficiency motor program in New York State was strictly an incentive program for the distributor and end user. It was funded by a systems benefit charge that applied to all users of electricity. This particular program provided an incentive to move up from EPAct motors to premium efficiency motors; it was essentially a rebate to bring down the cost of owning more efficient motors. It provided an incentive to the distributors to move those products and was a win-win program for both the dealer and the user. It was quite effective in achieving much higher penetrations of the more expensive — but more efficient — NEMA Premium motors than would otherwise have been the case."

Other states may have similar programs worth investigating. Since EISA legislation mandated NEMA Premium motors, many utilities have discontinued their rebate programs. Nonetheless, it is worthwhile to investigate whether "above NEMA Premium" incentive programs exist following the enactment of EISA on December 19, 2010. The "above NEMA premium" efficiency designation often is referred to unofficially as "ultra-efficient" or "super-efficient."

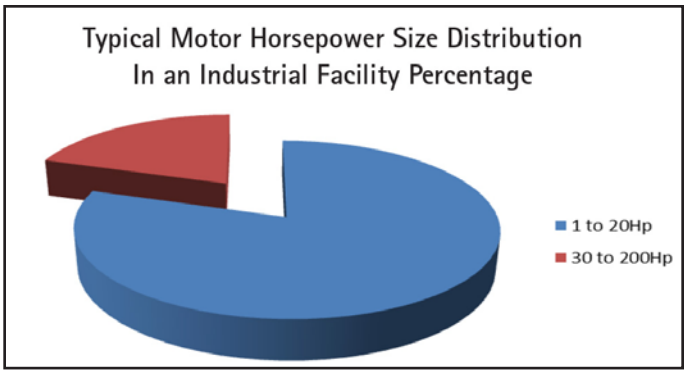


Figure 3 Percentage of motors in facilities by horsepower.

Motor sizes and quantities. What motors should I stock and how many? The goal is to match the most efficient motors for the job to your needs. The following sections will provide some insight to help you decide.

Small Motors, Big Savings

Eighty percent of the motors in most facilities are 20 horsepower or less (Fig. 3). These have lower efficiencies than larger motors, so there is an opportunity for significant gains when they are replaced with NEMA Premium motors.

A graph (Fig. 4) — Motor Horsepower versus Percent Efficiency Difference — was created using the efficiency table from Advanced Energy. It illustrates the one-to-three-percent efficiency gain that can be realized for motors up to 50 horsepower. The biggest improvements are for motors up 20 horsepower. Motors above 50 horsepower present lesser percentage gains in efficiency.

Douglass explains, "The emphasis has been on larger motors. That's an appropriate starting point for your plan, but smaller motors are important, too. They typically are more numerous and the gain is much higher. Smaller motors of the standard type with efficiency in the 80 percent range allow for more improvement. If you have many of these motors then you can save a great deal of energy. Sometimes a facility has a huge number of small motors driving things, such as a conveyor belt system; upgrading to a more efficient standard results in huge savings."

Severe-Duty Motors

In harsh operating environments, or whenever motors frequently fail, IEEE-841 severe-duty motors are a good option. McCoy provided an example through his work with the mill in British Columbia. He concludes, "There are two reasons why they were looking at extra-tough IEEE 841 petroleum and chemical duty motors and severe duty motors. One is the perception that the motor is going to last longer with more uptime; the other reason is that these motors carry a longer warranty. Generally, IEEE-841 motors have a five-year warranty and NEMA Premium motors about three years; for

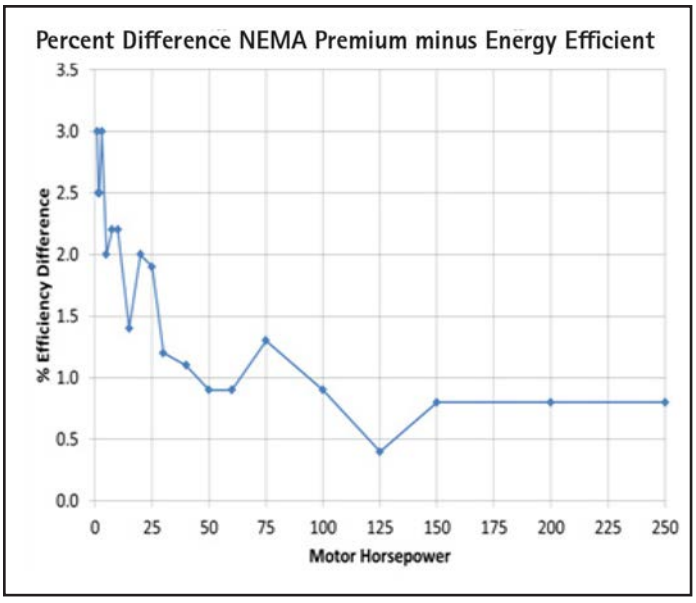


Figure 4 Motor horsepower vs. percentage efficiency difference.

comparison, general purpose motors and even EPAct efficiency motors typically are warrantied for only one year."

A final example comes from Joe Anderson, maintenance manager at Interface Solutions, Beaver Falls, New York — the largest producer of automobile gaskets. He is highly motivated to minimize downtime using IEEE-841 motors. "We depend on the reliability of the severe-duty NEMA Premium motors to minimize the shutdowns resulting from rooftop fan motor failures," he says.

Payback Calculations

Payback calculations are essential. Returns on investment in 9–24 months make sense. But where an EPAct or older motor is used in an intermittent duty application, where the motor runs only a few hundred hours a year, removing a functional motor for replacement with a new NEMA Premium motor is not a good investment. Look for applications with a quick payback period.

Sharing Inventory Data

Distributors are invaluable. They see your present needs and anticipate your future needs; they can also alleviate some storage space concerns. Distributors understand what motors are available and can provide appropriate solutions.

Kenny Jacobs, controls and drives product manager for KJ Electric, Syracuse, NY, describes the relationship between a distributor and its customers. "As an EASA motor shop, KJ Electric provides motor survey assistance to its industrial customers. This assistance includes, for example, helping its customers minimize inventory by cross-referencing the one motor that is suitable for replacing multiple motors."

McCoy concurs, "*MotorMaster+* is useful when you have an in-service motor inventory because you can share inventory data with your motor distributor. You can easily discuss with the distributor which additional motors you are likely to buy and which he should keep in stock. In this manner, premium efficiency motors are ready to use in a spares inventory at the distributor's storeroom instead of your own warehouse."

Systems Approach

Look for energy savings in the entire system. The system extends from the step-down transformer at the switchyard or plant service entrance, to the motor-driven equipment and process controls. Anything you can do to reduce system losses saves energy.

Benkhart notes that "The motor represents a huge opportunity for energy savings, but motors also are attached to systems. Whether a pump, air conditioner, or compressor — the system has its own associated losses. While many systems would benefit from variable frequency drives, other savings beyond the motor are possible. You have the transmission via a belt, a pulley or a direct drive; and then the system itself. The energy savings could be massive. There could be 50 percent savings in the system itself absent the motor. Before embarking on those system challenges, however, start with a motor that is the most efficient it can be."

Variable Frequency Drives

Fans, mixers, conveyers and pumps are all good candidates for variable frequency drives, or VFDs, which match motor speeds to varying load requirements. VFDs enable motors to run at speeds lower than the rated speed. Less energy is wasted and in-line flow restrictions such as throttling valves or inlet discharge dampers can be eliminated.

One believer in VFDs is Douglass, who says, "Often some of the greatest savings are realized by converting fixed speed drives to variable frequency drives. In airflow or liquid flow situations, a motor often drives a fan or pump and an air damper or a valve modulates the flow. In these situations, double-digit savings can be realized by converting to an electronic variable frequency drive. These motor controllers can be retrofit to an existing motor application and accomplish tremendous savings by eliminating the pressure drop associated with a modulating valve or a damper, whose functions are replaced by simply slowing down the speed of the motor. In these situations, you can save as much as 40 percent in electrical energy costs, depending on the fraction of time the system operates at a lower flow."

VFDs are cost-effective; they increase productivity, lower operating costs and waste less energy. Joe Anderson at Interface Solutions comments, "Our plant's variable speed drive inverter duty ready NEMA Premium motors are working very well. Our process needs exact amounts of flow, and the loads vary all over the place. With the variable speed drives, we can better control the process."

Match Motors to Load

Overloaded motors tend to run hotter; motors that run too hot tend to fail earlier than motors matched properly to the load. The life of the motor insulation is reduced by one-half for every 10° C rise in motor temperature.

Motors can run somewhat overloaded for short time periods. The nameplate on the motor gives a service factor multiplier that is the percent-operational-overload acceptable for

the motor. A service factor of 1.15 indicates the motor can operate 15 percent overloaded without seriously damaging the motor, but one should not expect the best performance or maximal service life.

As an example, see the image of the nameplate (Fig. 5) from a Baldor Reliance motor whose service factor of 1.15 is circled in red in the image, i.e. — SER. F. 1.15.

So far, it has been assumed that the supply voltage is within specified limits. An under-voltage contributes to an overheating condition, too, putting undue stress on a motor.

Douglass says, "When matching the motor to the load, be careful to not undersize the motor. It is particularly bad when the motor is undersized and the voltage is under voltage. This combination tends to make the motor run too hot. When a motor runs hot its service life is shortened. Even if the voltage is correct an undersized motor running into its service factor will be operating at a temperature higher than its design temperature — thus shortening its life. Service factors are often 15 percent, but can be as low as 0 percent when the motor is controlled by an adjustable speed drive. Sometimes the service factor can be higher than 30 percent. One should never plan to operate very much or often in the service factor."

Space Constraints

Be cognizant of space limitations when specifying a motor as a replacement for existing EPAct or standard-efficiency applications. Not all of the motor dimensions are specified in NEMA standards; some motor dimensions are specific to each motor manufacturer.

Check a "NEMA Motor Dimensions Reference Chart" against your space limitations or contact your motor distributor for any dimension in question.

McCoy adds, "NEMA has a frame assignment series. Motors are interchangeable parts. Premium efficiency motors, energy efficient motors, and standard efficiency motors all have the same mandated dimensions and tolerances set by NEMA. The one difference between a premium efficiency motor and a standard efficiency motor is that the former may stick out further in the off-drive end direction. If you are space-constrained, then talk with your motor supplier to obtain the dimensions of the new premium efficiency motor and ensure it fits before you place an order."

Financial Feasibility

Is the move to these energy-efficient products financially feasible? The answer is a resounding "Yes!"

Energy-efficient motors are among the best investments available, especially considering the high cost of energy and today's uncertain economic environment. Electric motor-driven equipment accounts for 30–50 percent of the electricity consumption in commercial facilities in the United States. Industrial facilities consume 60–70 percent.

Butler advises, "Motors belong to a very important electric technology classification because they use a lot of energy. The lifecycle costs of an electric motor are comprised mostly of payments for electricity. Anywhere from 97– 98 percent of the total lifecycle cost is for electricity; only two to three percent is invested in the initial capital cost to purchase that motor and in the maintenance cost as well. When considering a new motor purchase, it is very important not to focus just on initial price but focus mainly on the efficiency of the motor. In the long run you will mostly be paying for the energy consumed by the motor."

Simple payback analysis shows the move to energy efficient products is feasible. Computing the return on your financial investment before investing the capital dollars is possible where energy is a factor.

Says Benkhart, "In the move to more expensive — but clearly more efficient products — the important considerations are the price of the new motor and the cost of operating a motor. While an incentive program helps reduce the purchase price of a higher-cost NEMA Premium motor, there is still the bigger expense of operating the motor. Reaching the correct answer requires many pieces of information, including the type of motor, how often the motor is in operation (duty-cycle, single or multiple shifts), the horsepower, the motor efficiency and the percent motor load as well as the local cost of electricity, which typically ranges from $0.04 or $0.10 per kilowatt-hour. By entering the data collected during an inventory into a software tool such as *MotorMaster+*, a range of payback periods for a variety of operating parameters and utility costs can be calculated. The resulting payback calculations will help determine the feasibility of going forward with new, efficient, NEMA Premium motors."

Benkhart adds, "Most companies will approve a decision to buy energy saving equipment if the investment meets the simple payback or ROI requirement of less than 18 – 24 months. For a motor operating more than 6,000 hours at roughly $0.10 per-kilowatt-hour, the analysis yields a simple equation that estimates payback somewhere between six and twenty-four months. If the extra cost of buying the new NEMA Premium motor is $300 but the annual energy savings is $400, the nine-month payback clearly meets the payback criteria. Such information gleaned from our assessments and software tools empowers the customer to make good financial decisions regarding energy efficiency. Absent motor population information and tools to collect and analyze the data to make an informed decision, the facility is running blind."

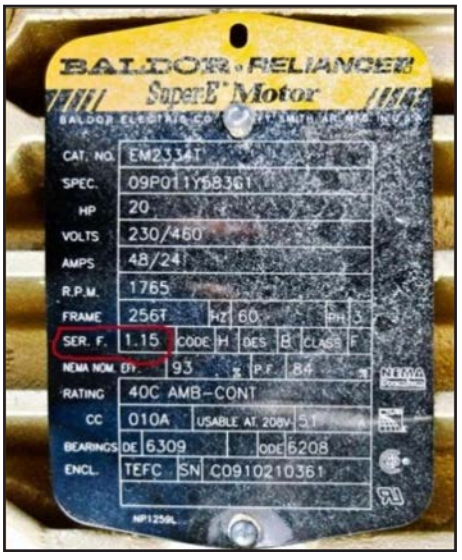
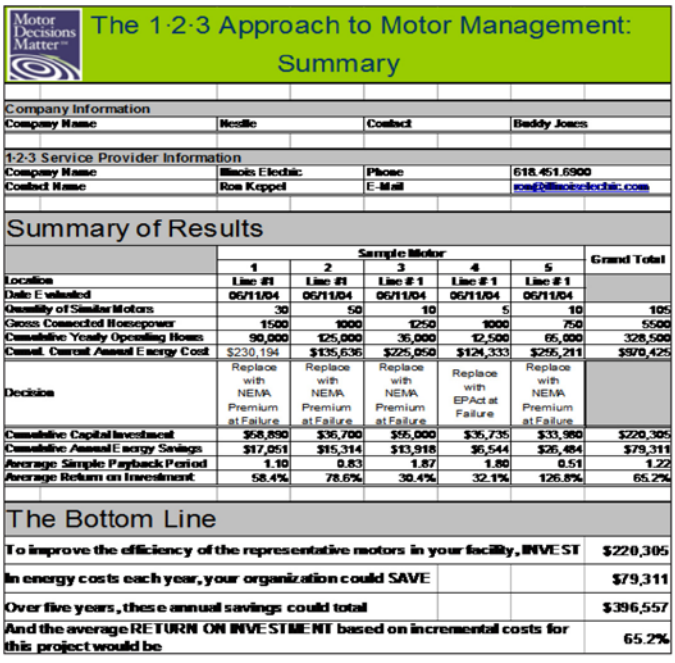


Figure 5 Baldor Reliance motor with service factor multiplier (circled in red) of 1.5.

There are many tools to help make such payback decisions. Besides *MotorMaster+*, many motor manufacturers offer their own proprietary tools.



The 1-2-3 Approach to Motor Management: Summary

Company Information

Company Name	Nestle	Contact	Buddy Jones

1-2-3 Service Provider Information

Company Name	Illinois Electric	Phone	618.451.6900
Contact Name	Ron Keppel	E-Mail	[redacted]

Summary of Results

	Sample Motor					Grand Total
	1	2	3	4	5	
Location	Line #1	Line #1	Line # 1	Line # 1	Line # 1	
Date Evaluated	06/11/04	06/11/04	06/11/04	06/11/04	06/11/04	
Quantity of Similar Motors	30	50	10	5	10	105
Gross Connected Horsepower	1500	1000	1250	1000	750	5500
Cumulative Yearly Operating Hours	90,000	125,000	36,000	12,500	65,000	328,500
Cumul. Current Annual Energy Cost	$230,194	$135,636	$225,950	$124,333	$255,211	$970,425
Decision	Replace with NEMA Premium at Failure	Replace with NEMA Premium at Failure	Replace with NEMA Premium at Failure	Replace with EPAct at Failure	Replace with NEMA Premium at Failure	
Cumulative Capital Investment	$58,890	$36,700	$55,000	$36,735	$33,980	$220,305
Cumulative Annual Energy Savings	$17,051	$15,314	$13,918	$6,544	$26,484	$79,311
Average Simple Payback Period	1.10	0.83	1.87	1.80	0.51	1.22
Average Return on Investment	58.4%	78.6%	30.4%	32.1%	126.8%	65.2%

The Bottom Line

To improve the efficiency of the representative motors in your facility, INVEST	$220,305
In energy costs each year, your organization could SAVE	$79,311
Over five years, these annual savings could total	$396,557
And the average RETURN ON INVESTMENT based on incremental costs for this project would be	65.2%

Figure 6 Example spreadsheet from 1-2-3 Approach to Motor Management Summary, from Motor Decisions Matter.

Advanced Energy Corporation, for example, has a motor management spreadsheet.

A sample spreadsheet is shown in Figure 6. It is derived from the Motor Decisions Matter 1-2-3 Approach to Motor Management tool at *www.motorsmatter.org/tools/123approach.html*.

This spreadsheet allows five motors to be examined alongside additional quantities from similar motors. It is an excellent tool for calculating payback and energy savings. The user is required to provide accurate information regarding repair costs and new motor pricing.

Summary

A motor failure policy built on the information provided in this work removes risk and indecision from the picture when a motor failure occurs. For example, tagging every spare and in-service motor in the facility with actionable information ensures that wrong decisions will not be made due to lack of such information.

Whether the policy stipulates replacing any motor under a certain horsepower, installing IEEE 841 motors in place of critical motors, or adherence to EASA guidelines for when repair is appropriate, you have taken the steps to minimize costly downtime and business interruptions.

Purchasing specifications developed using the technical tools and industry resources presented in this publication could serve as the blueprint or reference document for your motor management plan. The document can specify what new technologies to invest in, such as ultra-efficient copper-rotor motors or VFDs; it can specify the number of commonly used motors to stock in your facility; and it can specify the tools to assess which motors are most efficient and which yield the highest energy savings and shortest time to payback. The purchasing specifications can also identify preferred motor distributors, who provide the best volume discounts, as well as pre-sales and post-sales support.

Although the percentages certainly require updating, it is worth mentioning that the U.S. Department of Energy reported in 1998 that only 11 percent of customers had written specifications for motor purchases and only two-thirds of those customers included efficiency in their specifications. **PTE**

Acknowledgements

CDA acknowledges the assistance of government and industry-based motor experts in the creation of the Motor Management Best Practices series. Contact information for the motor experts cited in this publication is as follows:

Emmanuel Agamloh, Ph.D., P.E. Motor Systems Engineer Advanced Energy Corporation, Raleigh, North Carolina (919) 857-9023, *eagamloh@advancedenergy.org*.

Bruce Benkhart, Director, Advanced Proactive Technologies, Springfield, Massachusetts. Mr. Benkhart is available at (413) 731-6546 *bruce@appliedproactive.com*.

Tom Bishop, P.E., Senior Technical Support Specialist, Electrical Apparatus Service Association (EASA), St. Louis Missouri. *http://www.easa.com*.

Kitt Butler, Director, Motors and Drives at Advanced Energy Corporation (AEC), Raleigh, North Carolina (919) 857-9017.*kbutler@advancedeneergy.org*.

Johnny Douglass, Retired Senior Industrial Engineer, Washington State University (WSU) Extension Energy Program (360) 956-2086 *douglass.johnny@gmail.com*.

Gilbert A. (Gil) McCoy, P.E. Energy Systems Engineer with the Washington State University (WSU) Energy Office, Olympia, WA. 360) 956-2086, *mccoyg@energy.wsu.edu*.

Rob Penney, P.E., Certified Energy Manager, Senior Energy Engineer at Washington State University (WSU). Mr. Penney is available at (360) 628-2053, *penneyr@energy.wsu.edu*.


Emmanuel Agamloh


Bruce Benkhart


Tom Bishop


Kitt Butler


Johnny Douglass


Gilbert A. (Gil) McCoy


Rob Penney

Preventing Roller Bearing Failure

THE QUESTION

I'm building a custom gearbox with 7075 T-6 spur gears, and I'm concerned that aluminum flakes will enter the races on the roller bearings (SKF 2307) and cause premature failure. So my question is—should I place an oil seal on the shaft first to protect the bearing—or is this an unfounded concern and I should mount the seal in the typical manner outside the bearing? Or both? Or go with a sealed bearing? I'm confused and could use your expertise, please.

Expert response provided by Norm Parker, bearing technical specialist for GM's driveline division at the Milford, MI Proving Grounds: Well, I have good news and I have bad news. The bad news is—you will likely get aluminum particles in your bearings. The good news is—it probably doesn't matter.

Gear material in bearings is literally a 100-year-old problem. There are two broad categories we can put what I will call "solid particle contamination" into. I used to call it "hard particle contamination," but people kept complaining—"It's not thaaat hard." OK—*fine*; "solid" particle.

So back to the two camps of particles; we have small and we have large particles. I know—they aren't "thaaat" large; but what we are talking about are particles that are large enough to create a small stress riser in the surface—which can lead to spall. These particles create dents that are large enough to see. If you made me draw a line in the sand between large and small particles, it would be around 50 microns. You can see in Figure 1 that these dents are quite large—well over 200-300 microns. This type of denting usually comes from something else actually failing. That "something" is often another bearing or some type of external contamination. The debris created by a gear mesh is much finer than this. Gear wear particles are closer to 10-30 microns. Those can still be troublesome if they are in heavy enough concentration, but unlike this visible denting, small debris creates a wear mechanism. Certain wear mechanisms can be a problem for some ball bearing applications, particularly for angular contact bearings that are preloaded and under heavy loads. The particles tend to concentrate in the center of the raceway and can eventually start degrading the surface and lead to premature failures.

You will not find any shortage of information meticulously breaking down the specific amount of contamination to bearing life degradation; use some caution with that. I have found many instances where new oil had more contamination than the recommended operating condition. All you can really do is run it and see how it does. If you are seeing raceways like I have (Fig. 2), then you are likely generating a lot of particles. But that in itself doesn't mean your system is doomed to failure. The good news is that aluminum is very soft compared to bearing steel and other common wear mechanisms we see in our systems such as gear steel and external contaminants like the fine Middle Eastern sand (Fig. 2). In the unlikely event that you do start seeing early failures, (which I doubt you will), almost all of the top bearing companies offer some sort of debris-resistant bearings. These usually involve some sort of additional surface hardening. There is quite a difference in performance/contamination between a typical 60 HRC bearing and a

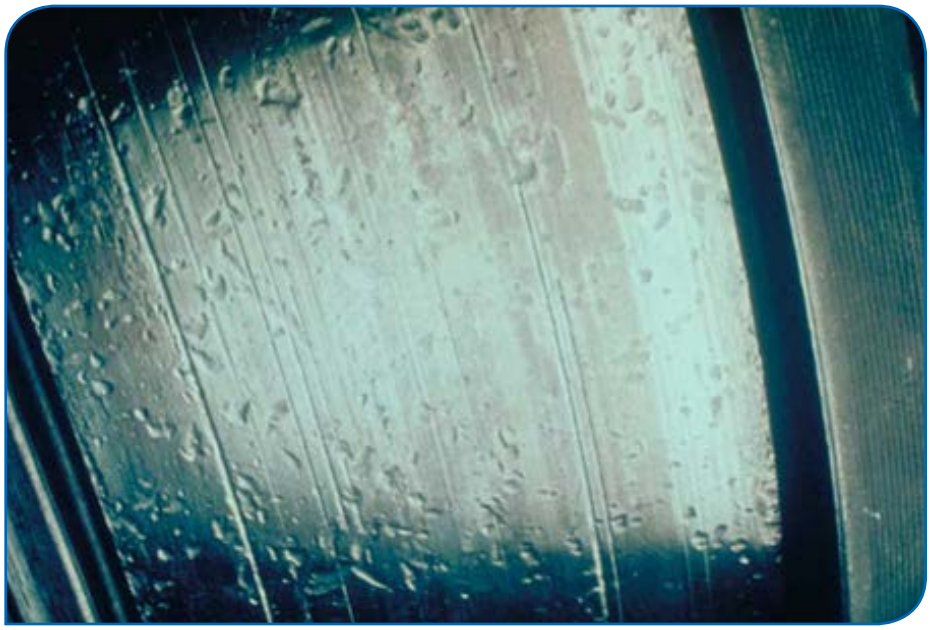


Figure 1 Go to *http://evolution.skf.com/damage-mechanisms-of-indentations-in-raceways-of-rolling-bearings.*

Figure 2 Warranty return from the Middle East.

For Related Articles Search
bearing failure
at www.powertransmission.com

premium 65'ish HRC bearing. Either way—I wouldn't lose any sleep over this application.

You'll be fine. **PTE**

Norm Parker is the bearing technical specialist for the driveline division at General Motors LLC. Located onsite at the Milford (MI) Proving Grounds, he is regularly *tas*ked with testing theoretical models in the real world, in real time. With his bachelor and master degrees in mechanical engineering from Oakland University (Rochester, Michigan), Parker has developed a keen interest in the academic, commercial and engineering aspects of the bearing industry. Prior to joining GM, he rose through the ranks of traditional bearing companies; by so doing he acquired invaluable experience in working with some of the largest customers — with the toughest applications and demands — on the planet. Parker plans to continue expanding his expertise and providing substantial personal contributions to bearing technology through metallurgy, design and processing.

Effect of Assembly Errors in Back-to-Back Gear Efficiency Testing

M. Andersson, M. Sosa, S. Sjöberg and U. Olofsson

As gear efficiency is improved in small steps, it is important to be able to distinguish actual improvements from scatter that can occur while testing. An FZG back-to-back gear test rig was used to investigate how the assembly and re-assembly of the same test setup affects the measurements. A spread in torque loss between one assembly and another of the same test setup were observed. Rig conditions also affected the spread in input torque. With knowledge of how the spread in torque loss varies due to assembly, test results could be distinguished between changes due to assembly and actual differences between tests.

Introduction

Testing of gears can be performed in various types of test rigs with different degrees of complexity, from clean model test rigs via functional back-to-back test rigs to full scale system test rigs. Because of the high efficiency of precision gear drives, and because progress in gear drive development are measured in tenth of percentages, for instance (Ref. 1) and (Ref. 2), makes it necessary to have low scatter between test setups, and to minimize errors that can occur while testing. This will make it possible to distinguish natural errors from actual improvements. While investigating noise and vibration, Åkerblom (Ref. 3) discussed that variations in measured noise and vibration with the same gear pair could be due to assembly. Oswald et al. (Ref. 4) also discussed the differences in noise level with the same gear system could be due to assembly. Sound and vibration are system parameters, just like efficiency. The sound generated from the contact between a gear pair is affected by bearings and bolted joints. Gearbox efficiency is affected by bearings, seals, oil level, as well as the contact friction between two gear teeth in contact. No sensitivity or uncertainty analysis has been found in literature on the effect of re-assembly on the efficiency of a back-to-back test rig.

In general, efficiency tests do not quantify the effect of assembly errors. With knowledge on how measured results might spread, future tests can then be compared to determine whether the test results should be ascribed to assembly, or to some other external factor, such as surface roughness and gear geometry.

The goal of this study is to increase the understanding on how and whether gearbox efficiency can vary due to assembly and re-assembly. To investigate this, both theoretical and experimental sensitivity studies were performed on an FZG back-to-back gear test rig.

Method and Materials

Test equipment. Theoretical and experimental sensitivity studies are defined as follows. The theoretical sensitivity study focuses on the uncertainty of the different parameters measured during an efficiency test. The experimental sensitivity study analyses the effect on the efficiency results of assembly, as well as other parameters such as oil level, preheating of the test rig, and unloading of the inside torque. Both studies were performed by analyzing an FZG back-to-back gear test rig with an efficiency test setup (Ref. 5). Efficiency was measured as input torque, torque loss, from the motor to the power loop. The power loop consists of the two gearboxes connected by a load clutch. A sketch of the rig can be seen in Figure 1.

The gear test rig was taken apart and reassembled between assembly tests. The order in which the test rig was disassembled is as follows. To be able to remove the gears in the slave gearbox (#3), the motor (#5), followed by the torque sensor (#4) were removed. The gears in the test gearbox (#1) were then removed. The opposite procedure was made to put the test rig back together, tightening all bolts to a specified torque. To minimize human error the same operators were used in all tests. The same standard FZG C-PT spur gears were used in the slave and test gearbox in all tests; their dimensions can be seen in Table 1. A running-in procedure (Ref. 5) was followed.

For dip lubrication, a commercially available polyalphaolefin with a viscosity of 64.1 cSt @ 40 °C and 11.8 cSt @ 100 °C, and a density of 837 kg/m^3 was then added to both gearboxes. An oil level to the center of the shaft was used in both gearboxes in all tests.

The procedure of taking the rig apart, putting it back together and adding lubricant is defined as one assembly.

FZG efficiency testing. To test the efficiency variation due to different assemblies the following test procedure was devised. The FZG gear test rig was assembled and then loaded to

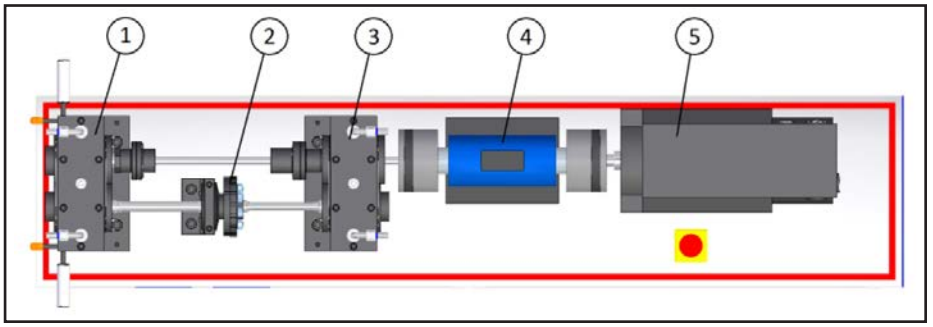


Figure 1 Schematic of the FZG back-to-back gear test rig with its most important parts: #1 test gearbox; #2 load clutch; #3 slave gearbox; #4 torque and speed sensor and #5 motor.

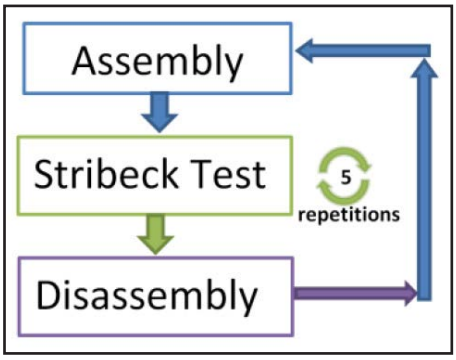


Figure 2 Flow diagram showing the order of the Stribeck test method.

94 Nm (FZG KS 5). Pitch speeds from 0.5 – 20 m/s were tested for five minutes at a lubricant temperature of 90 °C in both gearboxes. This test procedure is known as a Stribeck test (Table 2). These tests were repeated five times sequentially for each assembly. A schematic diagram showing this procedure is shown in Figure 2. In all assemblies, an oil level to the center of the shaft was used. The same assembly and disassembly procedure was used in all assembly tests.

The first four assemblies were used as a benchmark for the subsequent assemblies; these consisted of the assembly procedure described above and running the test combination shown in Table 2. In the first four benchmark tests the oil level was controlled by visual inspection.

Three further test conditions were chosen to investigate their effect on the spread in measured torque loss. They are as follows:

Loading and unloading, assembly 4UN Loads between 0 – 535 Nm can be applied to the gear rig; it is most likely that the same load will be tested several times — not necessarily in the same test plan. To study the influence of deviations in inside power loop loading, the torque was unloaded and loaded to the same value at the beginning of each speed repetition. This test was denoted as 4UN because it was performed using the same assembly setup as in test four.

Oil level, assemblies 5 and 6. Dip lubrication is the most common way to lubricate a gearbox, where the gears splash in the lubricant. The oil level is important when studying efficiency, since churning losses can be significant. Following the five initial tests, two assembly tests (5 and 6) were performed to determine the influence of oil level on efficiency. The initial four assemblies and the unloading test (4UN) were performed by observing that the oil level was at the center of the shafts, without measuring the oil level itself. In assemblies 5 and 6 the oil level was set to 103 mm, with a precision of ±1 mm from the bottom of the gearbox, corresponding to the center of the shafts.

Pre-heating of the gear test rig-assemblies 7 and 8. Components expand due to the substantial increase in temperature that occurs when performing standard efficiency tests, which in turn might affect results. In order to determine the influence of pre-heating the test rig before a Stribeck test, two assemblies were preheated for twelve hours to 90 °C prior to testing, with testing oil at standstill. The oil level was measured to be 103 mm in these assemblies as well.

Table 1 Basic geometry of the test gears used

Parameter	Unit	Gear	Pinion
Number of teeth	–	24	16
Module	mm	4.5	
Centre distance	mm	91.5	
Face width	mm	14	
Tip diameter	mm	118.4	82.5
Pitch diameter	mm	109.8	73.2
Pressure angle	°	20	
Working pressure angle	°	22.4	

Table 2 Test schedule of the Stribeck tests

Test number	Load [Nm]	Seed [m/s]	Duration [min]	Lubricant temperature [°C]
1	94	0.5	5	90
2	94	1	5	90
3	94	2	5	90
4	94	8.3	5	90
5	94	15	5	90
6	94	20	5	90

Theoretical sensitivity study, uncertainty in measured data from Stribeck tests. Test results can also be affected by the uncertainty of results of the measured variables. In each Stribeck test the temperatures in the test and slave gearbox, the torque inside the power loop, and the speed and input torque from the motor were measured. In this test rig eight outputs with a range of 0 –10 V and a 12-bit resolution are provided by the manufacturers. These voltages are multiplied by pre-set scaling factors to achieve the appropriate sensor reading. The voltages are sampled using a DAQ NI-6009 12-bit resolution analogue to digital converter, over the range of 0 – 10 V. A sampling rate of 1 Hz was used. The sensors are described below.

Torque meter inside power loop. Torque is loaded onto the shaft to the right of the load clutch (Fig. 1; # 2). However, the inside torque is measured on the shaft left of the load clutch by a full bridge torsional strain gauge connected to a telemetry system. The left shaft is calibrated to have a linear relationship between applied torque and angular deformation.

The torsional strain gauge is a full bridge configuration, with the four equal strain gauges to be connected around the perimeter of the shaft at 60 mm from the gearbox sidewall. Being a full bridge configuration, strain gauge measurements are insensitive to temperature. The telemetry system as a whole has a signal bandwidth from 0 – 10 kHz; sensitivity drift of 0.015% /°C; a resolution of ±0.030 Nm over the full-scale output; and a full-scale output error of 0.3% and nonlinearity of 0.2% — from 60 to 368 Nm.

Loading is performed by applying a torque onto the clutch (Fig. 1; #2). The torque can be decomposed into two components, the force and the lever arm. Force is applied by dead weights onto the lever arm (the weights have a tolerance of ±5 g). The lever arm is 500 mm from the center of rotation. But due to large shear strains when testing, the action line of the force may not be perpendicular to the lever arm if the lever arm at the start of the test is perpendicular to the real torque loaded onto the rig. The position of the load on the

lever arm is controlled by a wedge on the loading bar, as well as a wedge slot. A quantifiable error could arise from the overall deviation in load torque due to weight, positioning, and angle of the loading; however, the inside power loop torque is corrected during the test by the operator who can adjust the torque to match the torque reading shown by the torsional strain gauge. The operator always ensures that the inside torque is ±2 % of the nominal load.

Torque meter outside power loop and speed. In each test the input torque was measured by an accurate torque sensor (Fig. 1; #4). This torque sensor can measure torques up to 200 Nm and speeds up to 8,000 RPM. It measures torque with a sensitivity of 0.05%/10° C and with a measurement uncertainty of ±0.08 Nm over the full scale output, including hysteresis.

A flexible coupling, tightened to a specific torque, connects the slave gearbox to the outside torque sensor, and this device in turn is connected to the input motor by an identical coupling. Guiding pins are used to align all three components — thus ensuring minimal misalignment between the shafts. These backlash-free flexible couplings help ensure that the system can self-align if misalignments do occur.

The input power is supplied by a three-phase servo-controlled induction motor (Fig. 1; #5). To determine its speed uncertainty during operation, its speed is measured during testing at all testing speeds. Results show a deviation of ±2 RPM over all speeds when compared to the nominal speed. It is, however, important to note that in this study speed is of minor importance because all measurements are compared using torque loss, effectively decoupling speed from efficiency.

Temperature sensors and control in the gearboxes. A PT-100 sensor is mounted in the oil sump between the gearbox casing and the gear, both in the test gearbox and slave gearbox. Typically, this sensor has an uncertainty of 0.03 °C – 0.15 °C (Ref. 6). Independently, the temperature sensor was shown to have an uncertainty of 0.2 °C when compared to a known source. Note that all tests were performed at a controlled temperature of 90 °C. No further inves-

Table 3 DAQ resolution versus sensor uncertainty

Parameter	Unit	Testing range	DAQ resolution	Sensor measurement uncertainty
Temperature TGB	°C	30-120	0.024	0.2
Temperature SGB	°C	30-120	0.024	0.2
Inside power loop torque	Nm	0-372	0.049	0.3% FSO Nonlinearity 0.2% (60 to 368 Nm)
Outside power loop torque	Nm	0-20	0.012	0.5 % FSO (0.08 Nm)

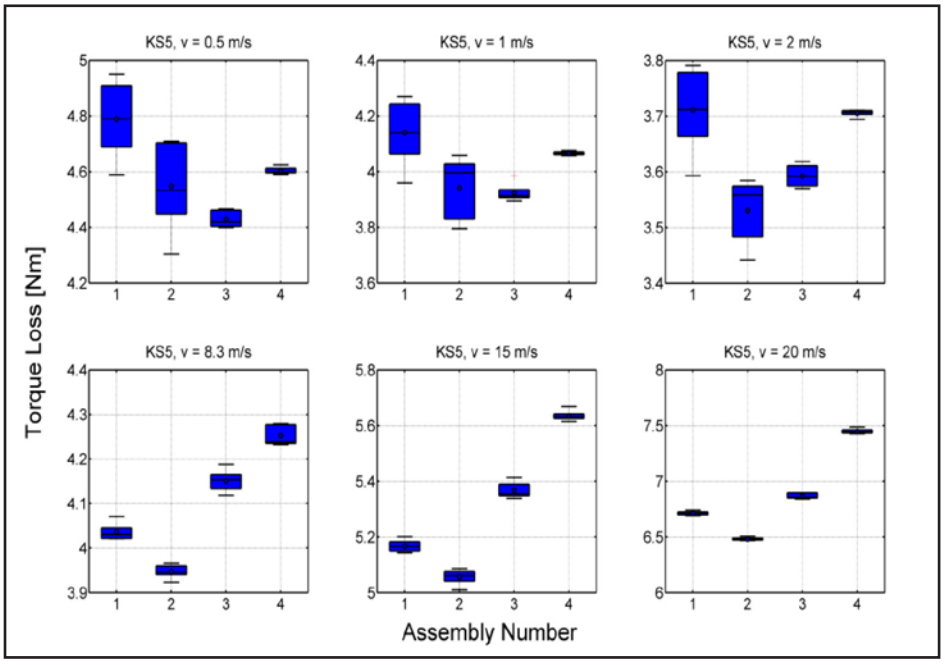


Figure 3 Reference error plot at 94 Nm, at 6 different speeds.

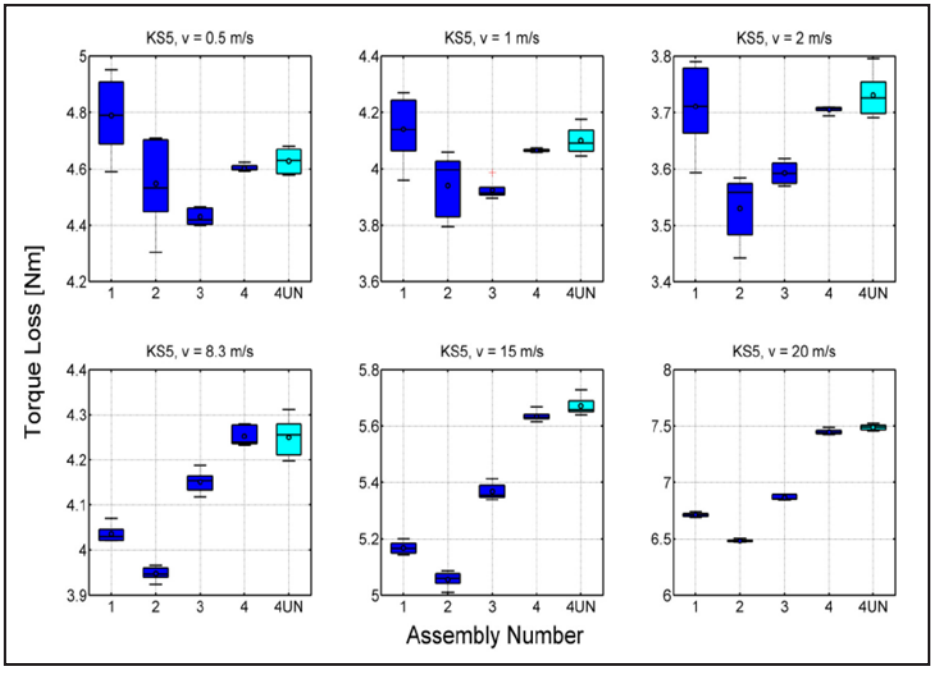


Figure 4 Comparing unloading of assembly 4 with reference error plot at 94 Nm, at 6 different speeds.

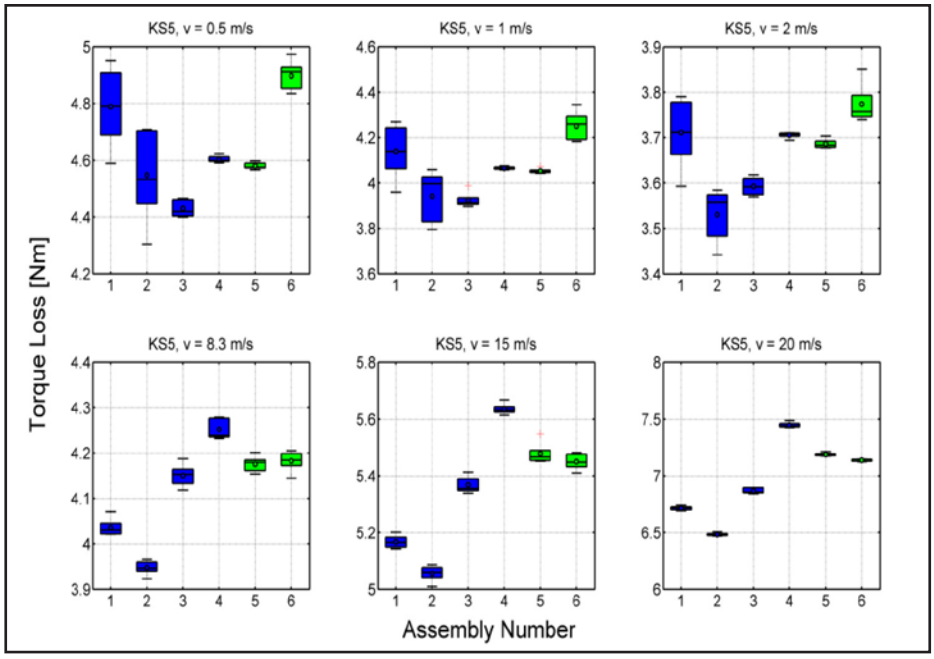


Figure 5 Comparing effect of oil level with reference error plot at 94 Nm, at 6 different speeds.

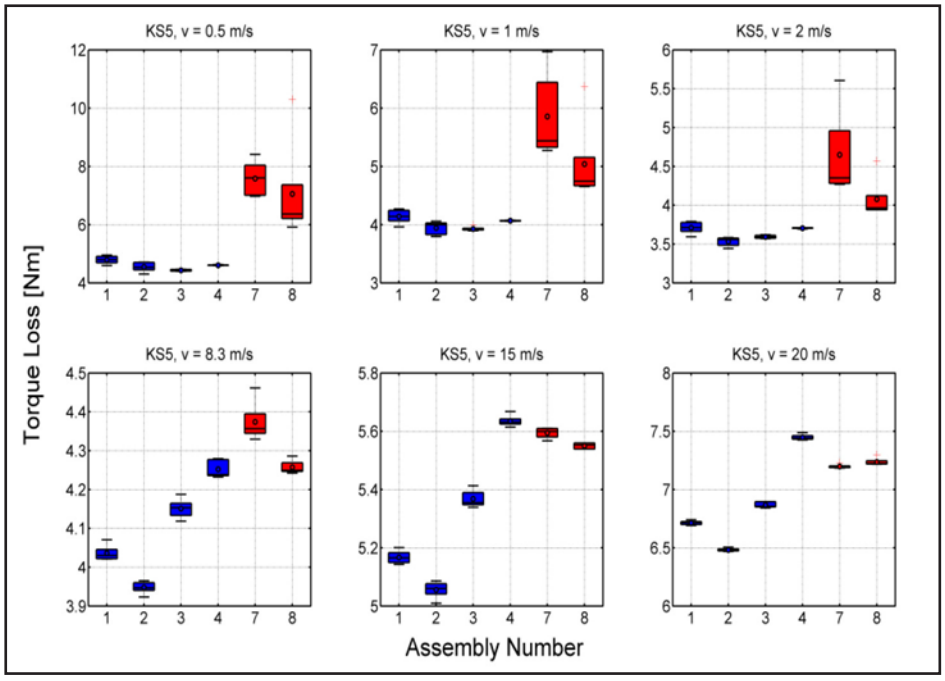


Figure 6 Comparing effect of preheating with reference error plot at 94 Nm, at 6 different speeds.

tigations were made to determine the uncertainty of the temperature sensors, as during testing the temperature is controlled to ±3 °C, making the sensor at least 3.3% accurate over this range of six degrees.

Signal processing. Table 3 shows efficiency test parameters as well as the DAQ resolution. At a 1 Hz rate over five minutes, each test has three hundred samples of all the parameters shown in the table below, which allows the means to be calculated. In the specific case of the outside torque, a tare value is calculated from the load at the start and end times of each test for each assembly. A statistically accurate tare is thus calculated, thus eliminating the zero drift over time.

Results for Stribeck Test and Assembly

The first four tests were devised as a benchmark measurement and to analyze the spread between them. Results are presented in the form of box plots. Box plots are defined as a graphical way to represent the median, upper and lower quartiles. In this paper a circle was added in each box plot showing the mean value, and the whiskers represent the maximum and minimum value in one dataset. Furthermore, if the boxes are separated from each other they represent a statistically significant result and can be interpreted as a graphical ANOVA with 95% confidence that the medians do differ. It can be observed by analyzing the different assemblies at different speeds that the spread is speed-dependent. Additionally, the scatter in assemblies 1 and 2 at low speed covers the same spread as the two subsequent tests. Furthermore, from 8.3 m/s onward, each assembly is statistically different.

Figure 4 shows the influence of unloading the inside torque. This variation in the test procedure compares the effect of assembly versus the effect of unloading and loading the inside torque. It can be observed that unloading does not change the level of torque loss, but does change the scatter for a specific test.

In Figure 5 the influence of setting a precise oil level (assemblies 5 and 6) is compared to the reference test (assemblies 1 – 4). The figure shows oil level does not influence the scatter of the torque loss at any speed, but influences the torque level in speeds from 8.3 m/s onwards.

Lastly, Figure 6 compares the effect of a long pre-heating period, 12 hours, to the first four assembly tests. A large significant difference can be seen below 8.3 m/s, in which both the scatter and level increase considerably. Mean torque loss at 0.5 and 1 m/s for the pre-heated test increased by almost 30–40%, while extreme values differ by about 200% at 0.5 m/s and 100% at 1 m/s. At high speeds the scatter is similar to tests 1 to 4.

In order to achieve one of the aims in this work, to determine the influence of the assembly methodology when measuring efficiency, tests 1 – 6, a pooled standard deviation was calculated to determine the spread in torque loss at each tested speed. Figure 7a shows the mean torque loss (continuous line), as well as dashed lines showing the

expected spread for ±1 standard deviation. As previously discussed, each speed has a different scatter in the torque loss due to the assembly methodology. From Figure 7a the maximum scatter over the entire speed range is ±0.45 Nm and a minimum scatter of ±0.10 Nm.

In order to estimate the reproducibility (signal-to-noise ratio) of assembly 1 – 6, standard deviation of the torque loss at each speed was divided with the mean value of the torque loss at each speed (Fig. 7b). The reproducibility varied between 2.42% and 5.04%; the best reproducibility was yielded at 2 m/s and the worst at 20 m/s.

Results for measurement uncertainties. The measurement uncertainties calculated from the root mean square of the DAQ bit resolution and the sensor measurement uncertainty are presented in Table 4. The measurement uncertainties in temperatures, inside power loop torque and outside power loop torque measurements are dominated by the sensor uncertainty.

Discussion

The four initial benchmark tests (Fig. 3) show a spread in torque loss between the same test setup for different assemblies. This is similar to the sound transmission results from Åkerblom (Ref. 3) and Oswald et al. (Ref. 4) regarding gearboxes where assembly influenced the system parameter sound. For system-level parameters, including gearbox efficiency, one must take into account the way the gearbox is assembled. The spread in torque loss for the three lowest speeds decreases for each assembly. It is not known whether this is due to wear after each assembly, or whether the operators had increased their assembly skill. The spread is lower for the three higher speeds between each assembly than what is shown in Figure 7a. This is because at higher speeds the mean torque loss is dominated by the amount of lubricant in the gearboxes (Fig. 5). To achieve a more realistic torque loss spread between assemblies (Fig. 7a), more tests are needed with the same oil height measurement method as in assembly 5 and 6.

Figure 4 shows a slightly higher spread in assembly 4UN, when unloading and loading to the same load in the same assembly. However, the torque loss is at the same level as the initial assembly 4. With a measurement uncertainty of 0.081 Nm in torque loss, all tests at each speed are within that range and thus can be said to come from the same assembly. It seems that unloading and loading with the same load does not have as large an effect on the measured torque loss as does a new assembly.

In assemblies 5 and 6 — in which the oil level was set to 103 mm from the bottom of the gearboxes — a difference in torque loss can be seen between the two assemblies at lower speeds (Fig. 5). In fact, assemblies 4 and 5 are very similar, but as the speed increases, the effect of an accurate oil level is shown. It seems that the differences in torque loss at slower speeds disappear as the speed increases, and speed-dependent losses dominate as full film lubrication prevails. A precise oil level minimizes unwanted differences in torque loss at higher speeds.

A comparison between the four initial assemblies and preheating for twelve hours can be seen in Figure 6. The torque loss between assemblies 1 – 4, versus 7 – 8, is significantly larger at slow speeds, but decreases as the

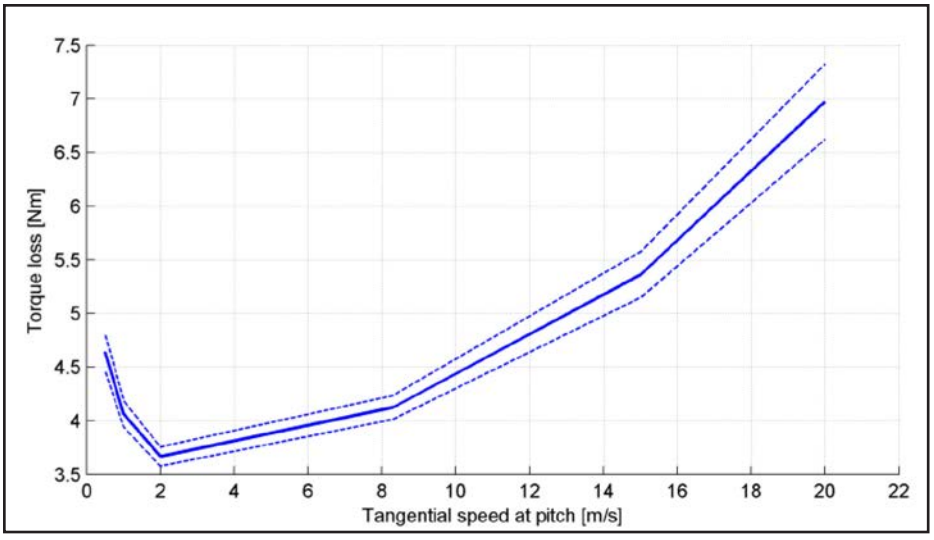


Figure 7a Mean and ±1σ of test 1 to 6. Continuous line mean, dashed line ±1σ.

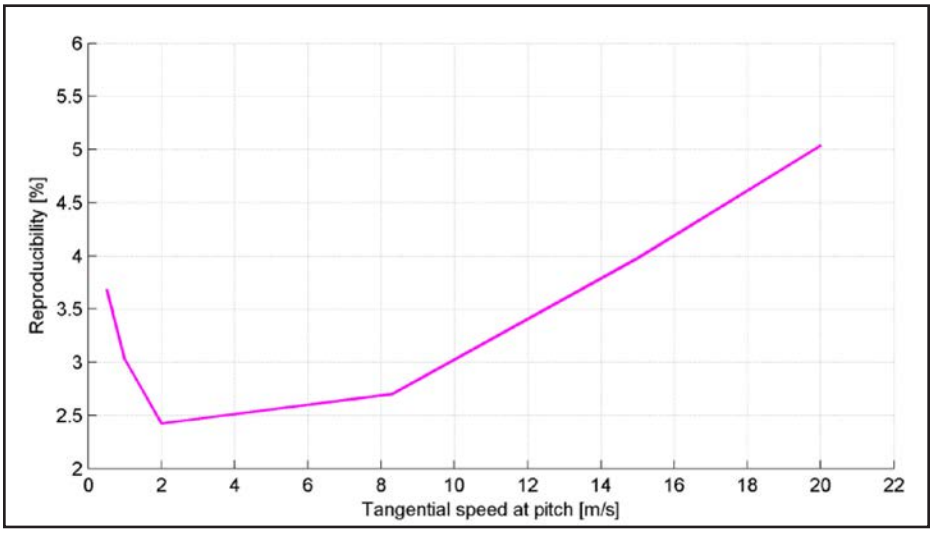


Figure 7b Reproducibility of test 1 to 6. Best reproducibility at 2 m/s

Table 4 Measurement uncertainties in the Stribeck tests

Parameter	Measurement uncertainty
Temperature TGB	0.2 °C
Temperature SGB	0.2 °C
Inside power loop torque	0.3% FSO Nonlinearity 0.2% (60 to 368 Nm)
Outside power loop torque	0.5 % FSO (0.08 Nm)

speed increases. The unloading (4UN) and lubricant level tests (5 and 6) do not differ as much in torque loss as when the gearboxes were pre-heated. The reason for this could be that the lubricant chemically reacts on the gear surfaces as the gearboxes are heated for an extended time (Ref. 7). The effect at low speeds may be explained by unwanted stresses in the assembly caused by expansion of components due to the increase in temperature. It is not known why the behavior changes at high speeds.

The sensitivity study investigated the uncertainty from each sensor in the Stribeck tests; except for the outside torque, the uncertainty with which test parameters can be measured in each Stribeck test is limited by the DAQ. An uncertainty of 0.081 Nm in outside torque loss, 0.3% FSO inside the power loop, and 0.2 °C in lubricant temperature should be sufficient resolution in this type of testing. Rather than utilizing a data acquisition device with better resolution, minimizing assembly spread (maximum value of ±0.45 Nm and minimum value of ±0.10 Nm) is more important to distinguish differences between tests. If maximum measured test results can be estimated, the scaling factors could then be lowered for better resolution.

Future efficiency tests can be compared using Figure 7a. It describes the mean and the standard deviation by pooling the four initial tests as well as assembly tests 5 and 6 (assembly tests in which the oil level was precisely controlled). Results of future efficiency tests can be compared to this spread to determine whether the results lie within the variation due to assembly or not. Furthermore, Figure 7b shows the reproducibility of assemblies 1 – 6. The lowest chance of a repeated test is at 20 m/s, where at that speed the oil level has a significant effect on reproducibility. Higher reproducibility will be achieved when the oil level is strictly controlled.

The test parameters in this study are commonly used with regard to the tested load and speeds; in order to achieve a more statistically accurate comparison, more tests at a controlled oil level should be performed. In standard efficiency tests efficiency is characterized by torque loss; however, if the true efficiency is measured, the speed spread should also be carefully considered. Also, since testing is performed at other loads, the effect of variations in load should also be determined. A test procedure that quantifies how much each test parameter affects torque spread is also required.

Conclusions

The spread in torque loss due to assembly methodology was quantified, as well as the overall uncertainty of measurements of temperature, torque and speed. From this study the following conclusions can be drawn:

- In the performed tests different assemblies having the same test setup give different measured torque loss. The spread in torque loss due to assembly methodology has been quantified. In these tests the smallest difference in torque spread is ±0.10 Nm and the largest difference is ±0.35 Nm (within a torque loss of 3.6 Nm – 7.5 Nm) when running at a load torque of 94 Nm between 87-3479 RPM in an FZG gear test rig.
- The overall uncertainty of measurements in temperature, torque and speed has been quantified in the gear test rig used. The measured uncertainty for the torque loss is smaller than the scatter from the different assemblies.
- Unloading and loading does not affect the torque loss level, but the spread is slightly increased.
- Variations in oil level are detrimental to torque loss level at higher speeds, and should be controlled for accurate results at those speeds.
- Pre-heating of the gear test rig increases the spread and level in torque loss at low speeds. **PTE**

References

1. Petry-Johnson, T. T., N.E. Anderson, D.R. Chase, and A. Kahraman. "An Experimental Investigation of Spur Gear Efficiency," *J Mech Des., American Society of Mechanical Engineers.* 130 (6):62601, 2008.
2. Martins, R. C., N.F.R. Cardoso, H. Bock, A. Igartua and J.H.O. Seabra. Power Loss Performance of High-Pressure Nitrided Steel Gears," Tribol. Int. Elsevier, **42** (11):1807–15, 2009.
3. Åkerblom, M. "Gearbox Noise: Correlation with Transmission Error and Influence of Bearing Preload," KTH, Royal Institute of Technology, 2008.
4. Oswald, F.B., D.P. Townsend, M. J. Valco, R.H. Spencer and R.J. Drago. "Influence of Gear Design Parameters on Gearbox-Radiated Noise," 1994, NASA TM, 106511.
5. Doleschel, A., K. Michaelis and B.R. Höhn. "Method to determine the frictional behavior of lubricants using a FZG gear test rig," Technical Report Research Project No.345, FVA, Mar 2002.
6. ELFA. *www.elfa.se.*, 2014.
7. Dizdar, S., Andersson, S. "Influence of Pre-Formed Boundary Layers on Wear Transition in Sliding Lubricated Contacts, *Wear*, Elsevier, 213 (1):117–22, 1997.

For Related Articles Search
gearbox efficiency
at www.powertransmission.com

Martin Andersson is a PhD student at the department of machine design at the KTH Royal Institute of Technology in Stockholm, with an M.Sc. in materials engineering earned in 2011 at Uppsala University, Sweden. Andersson's current research topic is gearbox efficiency, with particular focus on load-independent energy losses.

Mario Sosa is a PhD student at the department of machine design at the KTH Royal Institute of Technology in Stockholm, with an M. Sc. in 2012 in machine design from the KTH Royal Institute of Technology, Sweden. Sosa's current research topic is running-in of gears.

Sören Sjöberg received his PhD in machine design in 2014 at Stockholm's KTH Royal Institute of Technology before joining the University of Gävle as a lecturer. His area of interest is gear tribology, with the focus on gear efficiency. Sjöberg has more than twenty years of experience in both mechanical design and production engineering, in that time working for ABB, Sandvik and Volvo.

Ulf Olofsson, a professor in tribology at the department of machine design at the KTH Royal Institute of Technology (Stockholm), received his PhD in 1996 based upon on a thesis on wear as failure mechanism in boundary lubricated rolling bearings. His main research interests include interfaces and especially simulation and prediction of friction and wear — mainly applied to problems in mechanical, automotive and railway engineering. Olofsson has published more than 100 articles in scientific journals.

Global Industrial Outlook: Oil Slick Cascading Through Sector

Brian Langenberg

Third-quarter earnings are confirming the worst-case scenario, i.e.—not only are energy-related end markets in a downturn, but conditions *continue to worsen*.

Maintenance, repair and overhaul (MRO) is holding up relatively well (which actually means down less), but upstream activity is getting killed. Two companies with "big project" oil and gas exposure are citing bad pricing with Emerson stated, "worse we've seen in years," and Flowserve confirming, "down 5-10%," on large projects. Here are energy-specific results for selected companies, quarter-to-date:

Canada will offer no respite. Not only will low oil prices (and the associated strong dollar) continue to weigh on energy and exports, but I also think you can kiss the Keystone Pipeline goodbye—even after 2017. New Canadian Prime Minister Justin Trudeau has voiced some support for Keystone XL, likely meant to garner electoral support out of Alberta; but his heart is with the "climate change" crowd and repairing Canadian relations with Obama. His life story and track record do not scream "drill baby drill."

Partial off-sets are on the horizon beyond 2016 from non-residential construction, improving home prices and municipal budgets. Caterpillar voiced optimism about a highway bill before year end which, now that we have a speaker, is possible. However, it is more of an extension of current activity and hardly a "rebuild the country" move.

Machinery outlook for '16 is negative. Aside from truck (replacement mostly), expect continued negative comparisons from oil and gas, mining, agriculture, and power generation.

Highway Bill: Not a hockey stick—but a stick

The recently passed $300 billion, 6-year measure is the longest-term highway bill in a decade. While not enough to drive significant growth, it is at least a markedly better Band-Aid than the shorter-term funding of recent years and, as a bonus for exporters, renews the Export-Import Bank for another few years (a boon to Boeing and other large manufacturers, but also smaller ones).

Oil Slick! The Procession of Pain Continues

		Jun13	Sep 13	Dec13	Mar14	Jun 14	Sep 14	Dec14	Mar 15	Jun 15	Sep 15
OIL & GAS											
Grainger	Canada - core r	+2	+4	+3	(2)	(3)	+6	+4	(4)	(6)	(12)
Wesco Intl	Industrial - core	(2.7)	+0.2	(3.2)	+2.1	+5.0	+7.0	+5.8	(4.1)	(10.2)	(14.2)
Ametek	EIG, O&G core	#1 up	#1 up	strong	up	+4–6	+3–5	+slightly	down	(10–13)	(12–15)
Dover Corp.	Drilling & Prod i				+4	+5	+9	+19	(15)	(30)	(31)
Emerson	Process orders	+8	+5	+3	+12	+9	+9–12	+7	(2)	(12)	(13)
Emerson	Process rev	+3	+6	+5	+1	+2	+5	+6	+2	(4)	(10)
Flowserve	O&G Orders	+8	(7)	+26	+3	+25	+18	up	(24)	(32)	(30)
Honeywell	HPS Core rev	+4	+7	+1	+3	flat	+5	+6	(3)	(4)	(5)
Honeywell	UOP Core rev	+11	flat	+17	+9	+6	+7	(1)	+9	(8)	(15)
General Electric	O&G Core rev	+8	+8	+8	+19	+13	+10	+0	+0	(4)	(7)
MINING											
Caterpillar	Resources - col	(34)	(43)	(49)	(33)	(25)	(17)	(9)	(9)	(11)	(17)
Caterpillar	Constr - LatAm	(4)	+12	+21	(2)	+1	(15)	(24)	(23)	(47)	(43)
Grainger	US Nat Res.	+4–6	+4–6	+4–6	+7–9	+4–5	+10–12	+10–12	(4–6)	(11–13)	(17–19)

Focus Company: General Electric (GE)

Suppliers to GE's Power Generation business take note. The Alstom deal is closed now and it is game on for them to find cost outs and supplier consolidation with the assets and business of Alstom. A major initiative of theirs will be building an effective service business in Europe to support the installed gas and coal assets of Alstom. This may be opportunity for you — or it may be a threat. Studying your exposure by product line is critical now to assessing your risk. CEO Jeff Immelt wants to go out with a win and this will be his trophy deal — or his albatross.

Further your career: On July 1, 2015 I took over as Chair (and Lecturer) of Graduate Business Programs at Aurora University. The Dunham Graduate School of Business MBA with a Leadership concentration is ideally suited for technical or engineering professionals seeking to gain the business skills, tools, and mentorship to further their careers. AU also offers adult degree completion programs.

Highly accomplished professional business people teach our courses, whether on ground or online (same professors).

Front-end career goal discussion and mentorship. We want you to succeed.

Rolling admission with six 8-week terms per year allows you to flex up/down depending upon your needs.

Focused curriculum: 12 classes — 7 core, 5 electives. Each core class is a basic building block you need; the electives are geared for your objectives.

Locations: Aurora, Illinois, Woodstock, IL and Online.

Contact blangenberg@aurora.edu to arrange for a phone or in-person discussion. **PTE**

Corporate Services: Langenberg & Company provides a range of consulting services — strategy, financial benchmarking, M&A pipeline development — for private or public companies and executives. Contact *Brian@Langenberg-llc.com* to discuss.

Brian K. Langenberg, CFA has earned recognition as a member of the Institutional Investor All-America Research Team, a Wall Street Journal All-Star, and Starmine Best on the Street. As Principal of Langenberg & Company, he advises CEOs and senior executives on strategy and capital markets, and makes numerous public speaking appearances. In July 2015 he was named Chair (and Lecturer)of Graduate Business Programs at Aurora University.

Ryan Fitts

PROMOTED TO DIRECTOR OF QUALITY FOR BALDOR ELECTRIC

Baldor Electric Company recently promoted Ryan Fitts to director of quality. In this role, he will be responsible for leading and directing Baldor's corporate quality program with a focus on addressing customer concerns, particularly around lead times, on-time delivery and root causes of product quality issues.

"Ryan's customer focus and his understanding of problem solving tools and processes make him a good fit for this role, and we are looking forward to having him in this important position," said Scott Fullbright, executive vice president of manufacturing.

Fitts joined Baldor in 2011 as a member of the Lean Core Team. Since that time, he has led the project team that established the 210 motor plant in Fort Smith, AR, and most recently, he was the company's director of logistics. He has a manufacturing background with prior experiences at both Whirlpool and Hallmark.

Fitts holds a bachelor's degree in Industrial Engineering from the University of Arkansas and an MBA from Washburn University in Topeka, KA.

Voith 715 SVL Variable-Speed Fluid Couplings

UTILIZED IN ESPO PIPELINE

The ESPO Pipeline is a project of the Russian pipeline operator Transneft and a showcase project for Voith hydrodynamic variable-speed fluid couplings, which Transneft has chosen for its operations in Russian Siberia. The pipeline operator is extending the throughput capacity of the Eastern Siberia Pacific Ocean Pipeline (ESPO Pipeline) and adding four additional pumping stations to the already existing ones.

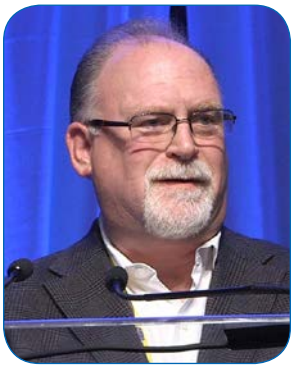
In all four stations, Voith variable-speed fluid couplings will control the pipeline pumps. Therefore, the company is to deliver a total of 17 hydrodynamic variable-speed fluid couplings to Transneft between January and December 2016. Sixteen of them will be installed directly; one coupling will be kept by the operator as a reserve.

The 715 SVL variable-speed fluid couplings that have been ordered transmit power of up to 6,350 kW at 3,000 rpm. Unlike electronic control applications, the couplings can be installed directly into potentially explosive atmospheres. They do not need their own building to be constructed or an additional gearbox with oil station either. For the operator, this means potential savings on investment, as well as maintenance costs.

The ESPO pipeline stretches over a total distance of 4,740 kilometers from Taishet to the transition point of the Kozmino oil refinery at the Pacific east coast of the country. In 2009, the first section (Taishet to Skovorodino) was completed; the second, from Skovorodino to Kozmino, followed in 2012. While the pumps in the pumping stations of the first section are controlled electronically, Transneft already uses four Voith fluid couplings in each of nine pumping stations in the second section.

John Masek

NAMED 25TH RECIPIENT OF PTDA'S WARREN PIKE AWARD



The Power Transmission Distributors Association (PTDA) recently named John Masek, senior vice president of Bearing Service Inc. (Livonia, MI), the 25th recipient of its Warren Pike Award for lifetime achievement in the power transmission/motion control (PT/MC) industry.

Masek received the award, named for PTDA's co-founder and first president, at the Association's Industry Summit in Chicago, IL. The award was established in 1984 to honor individuals who have demonstrated outstanding, continuous, long-term support of PTDA and the PT/MC industry, and is only presented when an individual's achievements merit this prestigious recognition.

Masek has been an active PTDA and PTDA Foundation volunteer for over 20 years, beginning his service on committees such as the employee relations, industry relations and communications committees. Masek served as a trustee for the PTDA Foundation from 2003-2005 and will be serving

again beginning in 2016. He was elected to the PTDA board of directors in 2004, continuing in additional officer positions during the years, culminating with a term as president in 2008.

Warren Pike Award recipients are selected by the PTDA Board and are not informed of the honor in advance.

"This is something I never thought to have," Masek said after receiving the award.

He thanked his wife, Sue Masek, for 33 years of support and Doug Savage, president of Bearing Service Inc. for getting him involved in PTDA.

Bearing Service is the first PTDA member organization to have two Warren Pike Award recipients and three PTDA presidents from among its employees.

InterVac

AWARDED PATENT FOR VACPORT SWEEPER PAN WITH LED LIGHTING

InterVac Design recently announced that it has been awarded a patent for its VacPort sweeper pan, the only such system that comes with LED lighting.

"The VacPort is a great way to make sweeping easier, acting as an automatic dust pan that connects into your central vacuum system," says Susan Schlapkohl, co-founder of InterVac Design. "All you have to do is grab a broom, sweep dirt toward the illuminated opening and your central vacuum system takes care of the rest."

interVac™ DESIGN CORP

VacPort features a LED lighting that puts a shine on the area near the pan. The VacPort is activated with a slight touch of a toe and can be used with any remote vacuum system in the kitchen, utility room, bathroom, workshop, hair salon or any other area that can be swept, Schlapkohl says.

The VacPort connects straight from the back of the unit into the existing central vacuum piping, making installation a snap.

Another of VacPort's features is that it's made of polycarbonate and comes with a lifetime unbreakable guarantee.

"Our company prides itself on innovation and the VacPort with LED lighting is another example of how we are always trying to provide a high-quality product at the best price for our customers," Schlapkohl says.

VacPort is now distributed through BEAM Electrolux, Desco and HP Vacuflo and, like all InterVac Design products, is made in the USA.

Timken

EXPANDS SERVICE CENTER IN WASHINGTON TO DELIVER MORE REPAIR CAPABILITIES

The Timken Company recently opened a 70,000-square-foot, motor and gearbox repair facility adjacent to its existing service center in Pasco, WA. Built to enhance service to Timken Power Systems' (TPS) customer base throughout the Pacific Northwest, the $7 million investment gives the facility additional capabilities to repair large electric motors, wind turbine generators and industrial gearboxes under one roof.

"We continue to grow our Timken Power Systems offering of services, working to provide customers in demanding industries with full drive train repairs — including gearboxes, motors, generators and large-diameter bearing repair," said Carl Rapp, vice president of the Timken Power Systems business. "This investment extends our U.S. regional service center network capabilities and positions us to more completely support our industrial customers in the Pacific Northwest to help them optimize their equipment lifecycle performance."

Leveraging the legacy regional strength of the H&N Electric services brand, TPS' Pasco service center houses some of the broadest repair capabilities in the region, able to serve customers in the wind energy, power generation, oil and gas, mining, pulp and paper, and agricultural sectors. Its layout optimizes space and features large-capacity cranes, lathes, ovens, VPI tanks and boring mills. With this equipment, TPS is capable of repairing electric motors up to 5,000 horsepower and wind turbine generators to meet developmental demands of 5 MW and larger. Additionally, the facility performs industrial gearbox repairs to the standards of Philadelphia Gear, the gear brand that stands at the center of the Timken Power Systems portfolio.

The facility features: fifty-ton crane lift capacity with 35 feet clearance under hook; twenty work station jib cranes; large-capacity vacuum pressurized impregnation (VPI) system with a 10-foot diameter and 24-inch shaft well, capable of processing a rotor/shaft length up to 14 feet; large-capacity burn and bake capability; enhanced machining capability provided by a 70-inch swing lathe, 60-inch horizontal boring mill, surface grinder and a 72-inch radial drill press; large-capacity dynamic balance capability on isolated and thickened slab; magnetic particle inspection; large-capacity 5,000 horsepower motor and gearbox test center capability; and dedicated production bays for large and small/medium sized motor repair cells.

"Our team has been eager to expand deeper into the Northwest market. We've been a leader in the wind market sector for some time and we recognize the larger industrial opportunity here," said Nathaniel Glessner, Timken manager of the Pasco facility. "It's exciting to now be able to develop that potential and offer existing customers larger motor/generator repair capacity as well as introduce new capabilities to a broader market."

Cicoil

OPENS NEW SALES OFFICE IN SOUTH CAROLINA

Cicoil recently announced the opening of a new sales office in Mount Pleasant, SC.

The move comes at a time when Cicoil is developing new products and manufacturing capabilities, so the office will be able to provide immediate technical support and cable design assistance for all Cicoil cables and fully terminated assemblies. The new location will be overseen by Cicoil's National Sales & Marketing Manager Rich Buchicchio, who has been with the organization for almost seven years.

"Cicoil is pleased to now have a more physical presence in the Southeastern USA, where we have had customers for many years," said Howard Lind, Cicoil president and CEO. "With the Mount Pleasant, SC location, we are very excited to now have the ability to interact with our clients face-to-face on a much more frequent basis, which we feel will help us to expand upon our success in this region of the country."

January 25-27—2016 AHR Expo Orange County Convention Center, Orlando, FL. The AHR Expo will put on display over 400,000 square feet of exhibits from nearly 2,000 companies representing every segment of the HVACR industry. The 2016 educational schedule will include many free seminars, exhibitor new product and technology presentations, ASHRAE Learning Institute seminars and courses, certification exams, and other programs offered by industry groups. Alongside the exhibits, the expo will feature several unique areas. The Building Automation and Control Showcase is an area on the show floor designated for the following products and services: building automation, energy and facility management systems, climate controls, monitoring systems, wireless and cloud-based options, and other networked building systems including lighting, security, fire alarms, and more. The Software Center is an area on the show floor designated for HVACR related software, both off-the-shelf and customized solutions, for the following: project and field service management, including estimating, inventory control and GPS tracking; systems design, specification and analysis; remote-based and cloud-based software; and more. The New Product and Technology Theater features brief exhibitor presentations of new products being introduced to the market—many for the first time at the show. No registration necessary. For more information, visit, *www.ahrexpo.com*.

January 27-29—SEMICON Korea 2016 COEX, Seoul, Korea. SEMICON Korea 2016 is the leading semiconductor technology event to explore the latest market trends and future developments for technology, featuring extensive technical forums, business programs and standards programs. They are the region's largest manufacturing event to display new products and technologies for microelectronics design and manufacturing, featuring technologies from across the microelectronics supply chain. This marks the show's 29th year. They will feature over 500 exhibiting companies from 20 countries and have more than 45,000 attendees. They are co-locating with LED Korea 2016. For more information, visit *www.semiconkorea.org*.

February 3-5—A3 Business Forum Disney's Yacht & Beach Club Resort, Lake Buena Vista, FL. A3 will bring together robotics, vision and imaging, motors and motion control professionals for a networking expo. Topics include global economics, disruptive technology, robotics and service excellence. Speakers include Alan Beaulieu (Institute for Trends Research), James Kuffner (Google Robotics), Dr. Robin Murphy (Texas A&M) and John Markoff (New York Times). The A3 Forum includes an optional golf scramble and robotic demonstrations from FIRST Robotics. For more information, visit *www.a3automate.org*.

February 9-11—MD&M West 2016 Anaheim Convention Center, Anaheim, CA. MD&M West will feature more than 2,000 medical suppliers demonstrating the latest technologies. Free presentations will be available at the Center Stage and Tech Theater with information regarding product development, Industry 4.0, mobile technologies, quality assurance, contract manufacturing, cyber security and more. Three networking programs are available to attendees including speed networking, a booth crawl and a conference networking program. In 2015, the Medical Conferences presented three tracks, featuring Disruptive Innovation in Design of Medical Devices; Managing Risk, Quality, and Validation; and Speed to Market and Post Market Compliance. In addition, conference sessions on the Internet of Things, Innovations in 3D Printing, Innovation in Design Boot Camp, Packaging Strategies, Packaging Optimization, and Quality in manufacturing packed in the audiences. For more information, visit *mdmwest.mddionline.com*.

March 3-5—Iptex 2016 Industry experts say that Iptex is the ideal platform for the Gears and Power Transmission Equipment industry to showcase their capabilities. It offers great opportunities to network between global buyers and potential partners and peers. Designed to meet the growing need for excellence in all aspects of the gears and power transmission industry, Iptex -2016 is an important event for all relevant stakeholders, be it automobile, aerospace, or energy - manufacturers, buyers, partners, and consultants. There will be a focus on enhancing productivity, improving efficiency and cost effectiveness, increasing levels of quality and reliability, superior finishing, improving aesthetics and design, and sharing best practices and ideas. Iptex will provide a consistent channel of communication to the members of this industry to come together under one roof and participate in technical seminars, share knowledge and expertise with industry leaders and to be a part of discussion on policy codes, standards and challenges faced by the industry. For more information, visit *www.iptexpo.com*.

April 5-7—Reliable Plant 2016 Kentucky International Convention Center, Louisville, KY. Reliable Plant is the industry's premier global event focused on lubrication, oil analysis and reliability. Manufacturing professionals from around the globe attend Reliable Plant to benchmark best practices, see and learn the latest technologies, and make new contacts. Reliable Plant features three days of comprehensive presentations and workshops covering today's trends and hot-topic issues. Professionals attending Reliable Plant Conference & Exhibition come from dozens of different machinery-centric industries, but last year's conference survey results indicate they all had one important thing in common: they learned something new. 76 percent of surveyed attendees said they were able to make changes in their workplace within 3 months of attending conference. The most common reason they cited was that their changes and ideas "made sense" to management and staff. Some were already seeing results. The people behind Reliable Plant claim that "attend, learn, apply" is the reason the conference exists. The 150,000 square foot exhibit hall, receptions, and sessions exist to facilitate the kind of learning and networking which will benefit and inspire attendees long after they leave. For more information, visit *conference.reliableplant.com*.

iptex 16

4TH INTERNATIONAL POWER TRANSMISSION EXPO

March 3rd to 5th 2016

Bombay Exhibition Center, Mumbai, India

A GEAR ENGINEERING EVENT

www.iptexpo.com

Mobilizing the World of Gears

For participation/information please contact:

Raghu - raghu@virgo-comm.com

Vashdev - dev@virgo-comm.com

A Concurrent Event

Grindex INTERNATIONAL 2016

2nd International Grinding and Surface Finishing Expo

CALL FOR PAPERS!

Are you sitting on an idea for a technical paper but wondering where to present it? Do you have one already written, sitting on your desk, gathering machine dust?

How about *Power Transmission Engineering*? We are always looking for gearing- and power transmission component-relevant technical papers for publication in the magazine and in its digital version. Having your work appear in *Power Transmission Engineering* guarantees you an audience of the most experienced and discriminating industry players. You say your work has not been peer-reviewed? Not a problem, as we are lucky—and thankful—to have on-hand some of the most experienced and brilliant minds in the industry—our technical editors. So if your work "passes muster" and is published, you'll know you were reviewed by the best—and most demanding.

Chances are you'll be creating the paper under the auspices of the company for whom you work or own, or for one of the various industry-relevant associations. That means they as well will bask in the reflected glory that accrues with publication in *Power Transmission Engineering*.

For publication guidelines and more information, please contact Jack McGuinn at *jmcguinn@powertransmission.com*.

ADVERTISING INDEX

Power Transmission Engineering

Power Transmission Engineering is Your KEY to understanding Gears, Gear Drives, Bearings, Motors, Clutches, Couplings, Brakes, and other Power Transmission Components.

Unlock your FREE subscription by filling out this form.

FREE SUBSCRIPTION

1

☐ **YES** I want to receive/continue to receive ***Power Transmission Engineering*** FREE!

☐ No thank you.

Name:_____JobTitle/Position: _____
(print)

Signature _____ Date: _____
(required)

2 → E-mail _____
(So we can notify you when the online edition is available)

SAVE a TREE!
☐ I ONLY want the digital edition (e-mail required)

3 → Please update your contact information or attach you business card here. (No Staples)

Company Name:_____

Address: _____

_____

_____

City:_____

State/Province: _____ZIP+4/Postal Code: _____

Country: _____

Telephone: _____Fax: _____

E-mail: _____

Website: _____

4 → How is THIS LOCATION involved with power transmission products? (Check all that apply)

☐ WE MAKE power transmission products (10)
☐ WE BUY power transmission products (12)
☐ WE SELL power transmission products (Distributors, sales reps. etc.) (14)
☐ WE DESIGN products with power transmission components in them. (16)
☐ Other (please describe) (15)_____

5 → My company's principal product or service is:_____

6 → What is your primary job function responsibility? (Check one)

❑ Corporate Management (1
❑ Plant Engineering (2)
❑ Design Engineering (3)
❑ Marketing & Sales (4)
❑ Manufacturing Engineering (5)
❑ Purchasing (6)
❑ Quality Control (7)
❑ Factory Automation (8)
❑ Maintenance (9)
❑ Other (10)
_____

Is there a colleague within your company that might benefit from having their own copy of ***Power Transmission Engineering*** magazine?

Name: _____

Title: _____

DIGITAL SUBSCRIPTIONS

❑ **YES, I want to be notified each issue when *Power Transmission Engineering* is available online**

❑ **YES, I would like to receive *Power Transmission Engineering*'s monthly e-mail newsletter**

❑ **YES, I would like to receive *Power Transmission Engineering*'s twice monthly e-mail Product Alerts**

❑ **YES, I would like to receive 3rd-party e-mails from *Power Transmission Engineering*'s advertisers and partners**

❑ **YES, I would like to receive subscription renewal notices by e-mail**

❑ **No, I do not wish to be contacted by e-mail.**

FAX TO 1-847-437-6618 or
VISIT US ONLINE AT
www.powertransmission.com/subscribe.htm

Hovercraft Technology Taking Us Back to the Future

ContiTech aids Griffon Hoverwork's pursuit of awesomeness

Erik Schmidt, Assistant Editor

There are few things in this world that elicit such a gleeful, childlike sense of wonder as does the word "hoverboard".

I mean, regular skateboarding is already "extreme" enough to merit a spotlight at the radically named X Games — now imagine taking off the wheels and the bearings and swapping them out for the good old fashioned reliability of unexplainable floating magic.

Plus, the hoverboard adheres to one of the infallible laws of the universe: If Marty McFly did it, then it's probably pretty cool.

Unfortunately, despite mean spirited lies perpetrated by "Back to the Future" director Robert Zemeckis, hoverboards don't exist. Not in the 1980s and not now. Some companies — most recently Lexus in June — have tried their hand at producing an honest-to-goodness levitating transportation device, but every attempt has been as sad and unfulfilling as Sisyphus trying to push that infernal boulder to the top of the hill.

(And let me stop you right now before you ask: Those self-balancing, two-wheel scooters libelously calling themselves hoverboards don't count. Shame on all of you. Somewhere in Hill Valley Doc Brown is rolling over in his grave).

But I have a silver lining for you: While hoverboards don't exist, hover*crafts* are very, very real and, consequently, very, very awesome.

In fact — and this is a true "Great Scott!" realization — they've been in commercial use longer than Michael J. Fox has been *alive*.

The modern day hovercraft was actually developed way back in the 1950s by a British mechanical engineer named Sir Christopher Cockerell.

Today, hovercrafts are used throughout the world as specialized transports in disaster relief, coast guard, military and survey applications. Very large versions have been used to transport hundreds of people and vehicles across the English Channel, while others have military applications used to transport tanks, soldiers and large equipment in hostile environments and terrain.

One of the premier hovercraft manufacturers in the world is Griffon Hoverwork, a British company founded in 1976 that produces hovercrafts with marine diesel engines.

Griffon recently designed two new hovercrafts that will be used as part of a ferry service from Portsmouth, England to the Isle of Wight. Both crafts use Synchrochain Carbon timing belts from the ContiTech Power Transmission Group. A 5,502 mm long, 220 mm wide Synchrochain Carbon connects the main shaft with the two-meter high propeller, while a 4,956 mm long, 60 mm wide timing belt of the same type connects the main shaft with the fan, which has a diameter of about half a meter. These are the longest endless polyurethane belts that have ever been made to date, according to a press release from ContiTech.

"We want to install the engines in the craft as low as possible in order to achieve a low center of gravity," said Selina Kefford, marketing manager and sales support at Griffon Hoverwork. "At the same time, we use the largest possible diameter propeller, because they turn more slowly and are quieter than smaller ones. With a low engine, but a large diameter propeller, it requires a long belt to get from one to the other."

The Synchrochain Carbon is a polyurethane timing belt with carbon tensile member from ContiTech. The heart of the belt is the carbon tensile member, which helps reduce stretching at high tension. This feature in combination with hard teeth made of polyurethane reduces the risk of tooth skipping significantly.

As Marty might say: Whoa, this is heavy.

Perhaps the craziest part in all of this — way stranger than the fact there have been air-cushion vehicles capable of zipping over land, water mud and ice with equal efficiency since before the Internet was a thing — is that the CEO of Griffon Hoverwork is named *Biff Tannen*.

OK, I made that last part up.

But honestly, it would have made a whole lot of sense if it was true. **PTE**

Too much pressure?

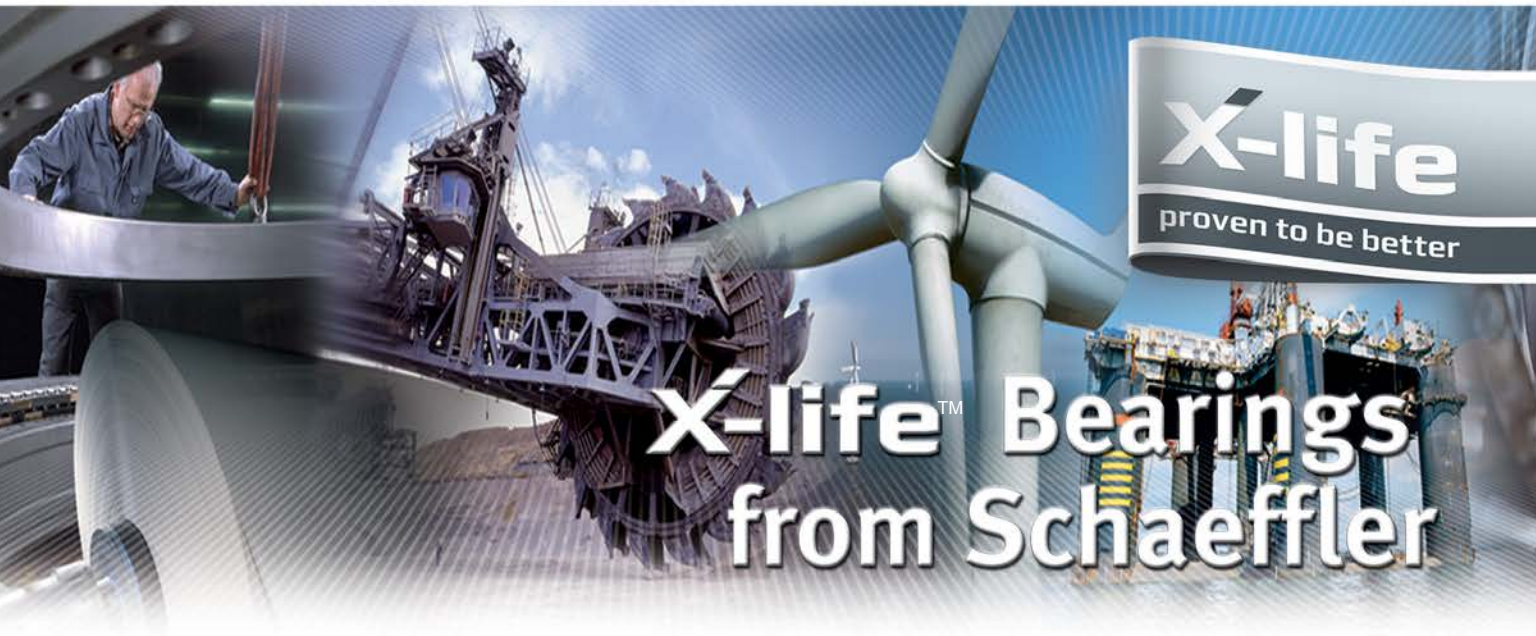
Are you under pressure to reduce costs? We can help! Independent research has proven that the **MOVIGEAR**® Mechatronic Drive System from SEW-EURODRIVE reduces start-up and operating costs in material handling by 20-30%. **MOVIGEAR**® also substantially reduces your inventory with its ability to cover a broad range of ratios within a single unit. So, relax...we got this!

SEW EURODRIVE

— Driving the World —

movigear.com / 864-439-7537

SCHAEFFLER



X-life™ Bearings from Schaeffler

More Capacity.
More Rigidity.
Less Friction.
Less Downtime.

Whether you need more or less, the solution is always Schaeffler.

Need more details?
Please contact us at
info.us@schaeffler.com
www.schaeffler.us

Superior-quality products.
Comprehensive reliable solutions.

INA FAG