

# PTE

powertransmissionengineering®

## Features

- The Sea Shall Have Them (Wind Turbines)
- Helical Gearing is Greener
- Smart House Makes Sense
- Industrial-Strength Gear Lubricants



[www.powertransmission.com](http://www.powertransmission.com)

**Power Play**  
Turbine-Powered  
Fire Truck Answers  
the Call, pg 48.

# Motors Motors Motors

you need them, we've got great prices on them!



## General purpose AC motors

IRONHORSE motors are available in rolled steel (1/3 to 2 hp) and cast iron (1 to 300 hp) 1800 RPM models. Selected 1200 and 3600 RPM units for the most popular horsepower ratings start at just \$70.

- T-frame cast iron three-phase, 208-230/460V up to 300 hp, TEFC enclosure
- 56C frame rolled steel single-phase, 115/208-230V, from 0.33 to 1.5 hp, TEFC enclosure
- 56C frame rolled steel three-phase, 208-230/460V, from 0.33 to 2 hp, TEFC enclosure
- TC frame (C-face) cast iron three-phase, 208-230/460V, up to 100 hp, TEFC enclosure



## Inverter-duty AC motors

MARATHON ELECTRIC inverter-duty motors have been carefully selected to be performance-matched with our DURApulse and GS series AC drives.

- 1/4 to 100 hp
- Dual 230/460V and 575 VAC models
- 1200 and 1800 RPM base speeds
- Factory-mounted encoders on select models
- NEMA Premium Efficiency XRI series from 1 to 10 hp compliant with Energy Independence and Security Act of 2007



## Heavy-duty DC motors

IRONHORSE PMDC motors are available in TENV and TEFC enclosure styles. Space-saving designs feature a NEMA 56C flange and removable mounting base.

- Rolled steel frame/cast aluminum end bells
- 0.33 to 2 hp, 1800 RPM
- Electrically reversible
- Compatible with SCR (thyristor) DC drives
- Large brushes for longer brush life, with easy access for replacement
- 90VDC and 180VDC models available

## Also Available



56C Gearboxes



Motor Bases  
(56-4497)



Order Today,  
Ships Today!

\* See our Web site for details and restrictions.  
© Copyright 2010 AutomationDirect, Cumming, GA, USA. All rights reserved.

## CHECK OUT OUR PRICES

PMDC Motors, 56C	AutomationDirect vs.	Baldor	Dayton	Emerson
0.33 hp, 90V 5079A-P03-1139	\$120.00	\$617.00	\$400.25	\$732.00
1 hp, 180V 2079A-001-1M18	\$195.00	\$1,019.00	\$651.00	\$1,212.00
2 hp, 180V 2079A-002-1M18	\$335.00	\$2,242.00	\$1,217.00	\$2,301.00

All prices are U.S. published prices. AutomationDirect prices are from Mar 5, 2010 Price List. Baldor prices come from www.baldor.com 2/2010. Dayton prices taken from www.dayton.com 2/2010. Emerson prices taken from www.emerson.com 2/2010. Prices and specifications may vary by dealer and configuration. Prices subject to change without notice.

[www.automationdirect.com/motors](http://www.automationdirect.com/motors)

[www.automationdirect.com](http://www.automationdirect.com)

Go online or call to get complete information,  
request your free catalog, or place an order.

1-800-633-0405



AUTOMATIONDIRECT  
the #1 value in automation



Photo courtesy of M. Cincala.

## FEATURES:

### Helical Gearing Offers Green Alternative

Upgrading to gearboxes with helical gearing can save on energy, maintenance and landfill space.

20

### Coastal Question Marks

Does North America's renewable energy solution lie offshore?

24

### High-Performance Industrial Gear Lubricants for Optimal Reliability

Advanced-technology gearboxes require OEM-specified lubricants.

29

### The Limbs of Lumenhaus:

Motion systems bring Virginia Tech's award-winning and energy-optimizing "Smart House" to life.

38



(Photo courtesy of GEARTECH)

## DEPARTMENTS

### Book Alert: Design of Brushless PM Machines

A must-read for motor designers.

6

### Products

Industry-new product launches of interest

8

### Events/Calendar

IMTS and AMT Get Social, other shows, conferences, etc.

40

### Industry News

What's new—and worth knowing

42

### Advertiser Index

Contact information for companies in this issue

46

### Classifieds

Our products and services marketplace

47

### Power Play

Vive La (American) France!—

Turbine-powered pumper truck was hell on wheels

48



## ONLINE



Follow PTE on  
Facebook and LinkedIn



- Power Transmission Engineering  
Sign up for a free subscription or read back issues online.

- [powertransmission.com](http://powertransmission.com)  
Our new look and feel includes online videos and more.

- BUYERS GUIDE  
Search for power transmission products and services and communicate with the industry's leading suppliers.

## GEAR TECHNOLOGY.com

- BUYERS GUIDE  
Search for gear industry products and services and communicate with the industry's leading suppliers.

- SUBSCRIPTIONS  
Sign up for subscriptions to *Gear Technology*.

- E-GT  
Subscribers get access to back issues of *Gear Technology*.

Randall Publications LLC makes every effort to ensure that the processes described in POWER TRANSMISSION ENGINEERING conform to sound engineering practice. Neither the authors nor the publisher can be held responsible for injuries sustained while following the procedures described. Postmaster: Send address changes to POWER TRANSMISSION ENGINEERING, 1840 Jarvis Avenue, Elk Grove Village, IL, 60007. ©Contents copyrighted by RANDALL PUBLICATIONS, LLC 2010. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system, without permission in writing from the publisher. Contents of ads are subject to Publisher's approval.

# WHO SAYS YOU CAN'T SEE THE FOREST (CITY) FOR THE TREES?

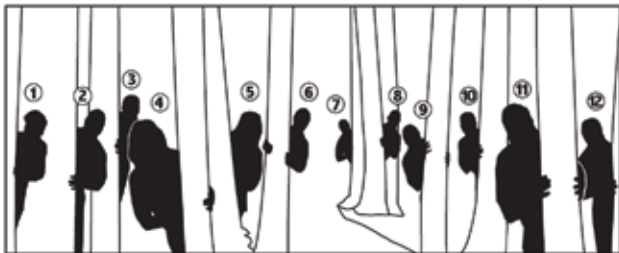


**Forest City Gear** has a very "easy to see" way of doing business. We look at your product, the purpose of the gears in the overall mechanical motion process, your manufacturing requirements and many other factors. Then, our Forest City Gear engineers help devise the best solution for your needs.

Using the industry's most advanced technologies for gearmaking and gear finishing, the next step is the production of prototypes for your approval. Often times, we see a better solution and suggest it immediately, because we have no "one size fits all" mentality in the

mind's eye at our company. It's precisely this flexible approach to gearmaking and our innovative thinking that's made us a longtime leader in the industry. That fact is borne out nowhere better than at the many other gear companies for which we work, helping them solve problems and performing machine operations that are recognized worldwide for their accuracy, repeatability and part verification protocol.

Forest City Gear people have a passion for what we do and that's also very easy to see, in the many gear industry awards and high standard recognitions we've achieved. Get the picture? Then, we invite you to look to Forest City Gear for your next "picture perfect" product. Go to [www.forestcitygear.com](http://www.forestcitygear.com) and have a "look" for yourself. Seeing is believing.



(1) Krista King, (2) Joe Luy, (3) Jim Cagle, (4) Wendy Young, (5) Kika Young, (6) Rustin Mikel, (7) Paul Lindquist, (8) Jared Lyford, (9) Gene Fann, (10) Tom Christenson, (11) Fred Young and (12) Bruce Haxton.



# PTE

powertransmissionengineering®

VOL. 4, NO. 5

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](mailto:publisher@powertransmission.com)*

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

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

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

**Editorial Consultant** Paul R. Goldstein

**ART**  
**Art Director** Kathleen O'Hara  
*[kathyohara@powertransmission.com](mailto:kathyohara@powertransmission.com)*

## ADVERTISING

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

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

## CIRCULATION

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

## RANDALL PUBLICATIONS STAFF

**President** Michael Goldstein  
**Accounting** Luann Harrold

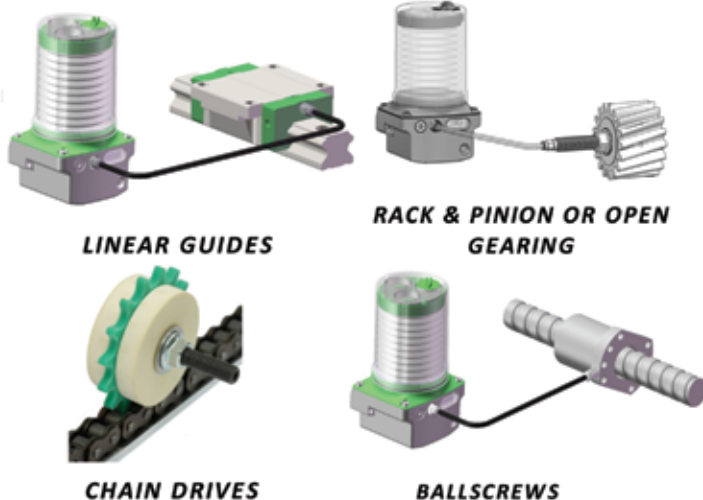
Photo  
courtesy of  
Lee Linear.



# ANDANTE

USA Inc.

## FLEXPUMP AUTOMATIC RELUBRICATION SYSTEM



Lubricate THESE COMPONENTS with the new compact, cost effective, user friendly and green Flexpump system.

- Automatic relubrication unit with piston pump (pump pressure of 70 bars) and programmable time & delivery rate settings!
- Includes up to 4 outlets for multi-point lubrication
- Power by internal battery or 24V DC supply
- Remote operation monitoring and setup available through 4 pin M12 connector
- Flexpump location can be 5-10 meters away from lubrication points.

For additional information on this system, visit [andantex.com](http://andantex.com) or call 800-713-6170.

1705 Valley Road | Wanamassa, NJ 07712  
Ph. 732 493 2812 | Fax. 732 493 2949

Email: [info@andantex.com](mailto:info@andantex.com)  
[www.andantex.com](http://www.andantex.com)

# PRECISION

## World-Class Precision Prototype and Short-Run Production Gears

**The premier gear manufacturer for Aerospace, Defense, Industrial and Automotive industries.**

Delta Gear products are recognized around the world for precision-quality and on-time delivery. Now we have the privilege of taking the TIFCO Gage & Gear legacy of products forward with us into the future.

Together, our superior manufacturing capabilities, highly trained workforce and ability to manufacture highly engineered and customized products set us apart from all the other aerospace gear manufacturers.

Our continuous capital investment in precision CNC machinery, trained personnel, ISO9001 and AS9100 registrations, non-destructive testing and engineering solutions deliver aerospace quality at automotive prices.



Formerly TIFCO Gage & Gear

*We Make The World's Finest Gears*

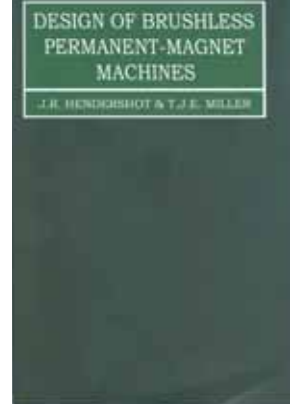


[www.delta-gear.com](http://www.delta-gear.com) | 1-734-525-8000 | 1-734-525-8400 Fax  
ISO9001 & AS9100 Registered

## New Book Updates a 1994 Classic on Brushless Permanent Magnet Motors

DESIGN OF BRUSHLESS PERMANENT-MAGNET MACHINES

By Jack McGuinn, Senior Editor



By J.R. Hendershot  
and T.J.E. Miller  
822 pages, published in USA  
by Motor Design Books LLC

The latest offering by machine design experts J.R. Hendershot and T.J.E. Miller is an 822-page brushless permanent-magnet (PM) machine design book that serves as a worthy follow-up to their 1994 work (*Design of Brushless Permanent-Magnet Motors*). The new entry—*Design of Brushless Permanent-Magnet Machines*—is rich in color illustration and is the direct result of extensive consulting by the authors in collaboration with a number of the preeminent producers of brushless permanent-magnet machine products. Much of the theoretical material derives from Miller's SPEED Laboratory at the University of Glasgow, acknowledged as a leading supplier of design software for electric machines—specifically, the theory text that accompanies the SPEED PC-BDC software developed by Miller. The book was written with a focus on real-life engineering practice and addresses the questions that typically arise on a daily basis in PM brushless machine design. As such, working engineers have used the 1994 book as a reliable go-to resource. In the update, there are many more examples than the 1994 book. The expertise on display in this volume is the result of the authors' long-standing partnership and combination of theoretical, practical and consulting experience. In addition, the book and its illustrations of industrial products are striking testimony to the incredible engineering accomplishments of design engineers around the world.

Following are brief notations for each chapter, all of which are indicative

of the depth of interest and knowledge to be found in this comprehensive study:


General Introduction; Machine Types and Applications; Basic Design Choices; FLUX, EMF and Torque; Inductance; Squarewave Drive; Sinewave Drive; kT and kE, and Figures-Of-Merit; Generating; Multiple-Phase Machines; Line-Start Motors; Losses and Cooling; and Testing, followed by a very detailed Appendix.

A sampling of accompanying sub-chapters includes: (1) Definitions and types of brushless motors; (2) Machine configuration; (3) Sizing—the ABC of electric machine design; (4) Permanent magnets and magnetic circuits; (5) Important practical effects of inductance; (6) Three-phase bi-polar drives; (7) Electronic control; (8) kT and kE of squarewave and sinewave motor/drives; (9) Configurations and loads; (10) Finite element analysis; (11) Analysis of polyphase and single-phase line-start motors; (12) Joule losses in stator conductors; and (13) Objectives of testing.

Add to this a very extensive collection of symbols, abbreviations and explanatory notes—and bibliography—and the result is perhaps a new gold standard for the study, understanding and implementation of brushless PM machine science

T.J.E. Miller, Ph. D., is founder and director of the Scottish Power Electronics and Electric Drives Consortium (SPEED). Members include over 100 industrial companies around the world. Miller led the development of theoretical methods,

design techniques and software used in the manufacture of electric motors and generators used in appliances, power tools, vehicle traction drives, aerospace and a wide variety of industrial products. An IEEE Fellow and Tesla Award recipient, Miller is the author of over 200 publications on motors, drives, power systems and power electronics, including nine books.

James R. Hendershot has over 40 years' experience in the practical design, development and manufacture of PM and switched reluctance brushless machines, as well as AC induction machines for inverter control. Mr. Hendershot has designed hundreds of machines for computer disc drives, machine tool spindles, traction motors, PM generators for micro-turbines and many other applications. His past employment includes Lear Siegler, Clifton Precision, General Motors, United Technologies and Pacific Scientific. He has written (or co-authored) numerous technical papers, publications and three books, plus 13 patents. An IEEE Fellow, Hendershot holds a bachelor's degree in physics from Baldwin Wallace College in Berea, Ohio. 



99.9% MECHANICAL EFFICIENCY  
NO LUBRICATION  
NO WEAR  
NO VIBRATIONS  
ENVIRONMENTALLY BRILLIANT  
USED IN AUSTRALIA SINCE 2001  
TESTED BY TORQUE TEST BV IN HOLLAND  
CUSTOMIZED SOLUTIONS AVAILABLE  
LONG LIFE - MAGNET LIFE SPAN - 50 YEARS +

# MGT

## MAGNETIC GEARS

Slip or non slip gears, arranged  
to meet client specifications.

[www.mgt.com.au](http://www.mgt.com.au)

[www.magnetpowertransmission.com](http://www.magnetpowertransmission.com)

Our gears can be used in sterile or hostile environments because they never touch and because they do not need lubrication. They are currently being tested in different facilities around the world, including NASA in the US.

### SLIP GEARING

stackable  
upgradable  
interchangeable  
programmable slip

### MESHED GEARING

teeth lock in levitation  
simple, rugged construction  
high start up torque  
run cold even under load  
no lubrication or maintenance

US 7,421,929 B2 patent granted, other patents pending worldwide

EXAMPLE  
MGT planetary magnetic  
gear box





## Motion Logic Controller

### LOWERS COSTS AND SIMPLIFIES INTEGRATION

The Bosch Rexroth MLC motion logic controller with Version 10 firmware is based on a one-gigahertz PAC controls platform that provides high-performance motion logic and robotics capabilities. Rexroth's most advanced platform supports real-time Ethernet communication on Ethernet platforms, including SERCOS III, Ethernet IP and ProfiNet for interfacing with connecting controls, drives, I/Os, safety, HMI, web and machine-to-machine synchronization, which helps to lower the controls cost and simplify integration for OEMs, systems integrators and end users. The MLC motion control has a free web-based service and engineering tool for easy access using a web browser to access the system data, and also has configuration tools for maintenance and commissioning. The system status and diagnosis of control hardware, drives and communication interfaces can all be viewed. The parameter editor, PLC variables and electronic name plate data

are also available.

The MLC uses the *IndraLogic 2G* PLC editor that offers several enhancements: new visualization concept for testing and monitoring functions, object-oriented programming in project structure, new data types, new operators and variables. *IndraLogic 2G* also supports standard IEC 61131-3 program languages such as: Function Block Diagrams (FBD), Ladder Diagrams (LD), Instruction Lists (IL), Sequential Function Chart (SFC), and Structured Text (ST). Suitable for the most sophisticated packaging and high-speed robotics applications, the Rexroth MLC powerful processor allows for control of up to 16 robotic kinematics concurrently, and up to 64 axes of motion and logic on a single controller. The latest *Version 10* firmware also provides advanced Flex Profile camming capabilities to help reduce engineering time and provide automatic cycle time optimization of machines and entire packaging lines. With Flex Profile, cams can be multi-segmented

and cycle times can be automatically optimized for velocity, acceleration, position or time to avoid having to rebuild cams each time a parameter changes. Flex Profile provides masters as an axis, as a specific time, or a combination of both. By changing values in the segments, the profile can be automatically modified to accommodate any changes in products. The MLC 10 can generate PLC function blocks for online creation of FlexProfiles, CAM preview with several axes simultaneously and provide definition of FlexProfile events.

#### For more information:

Bosch Rexroth  
5150 Prairie Stone Parkway  
Hoffman Estates, IL 60192  
Phone: (847) 645-3600  
[www.boschrexroth-us.com](http://www.boschrexroth-us.com)

## Shaft Collars

OFFER HIGH HOLDING POWER AND CONTROLLED FACE TOLERANCE

Ruland Manufacturing Co., Inc. offers a full range of shaft collars with controlled face tolerance and high holding power. Shaft collars can be used on a variety of equipment including motors, gearboxes, linear actuators, packaging equipment, printing presses, medical devices and precision instruments. Ruland shaft collars are single-point faced during the boring process to ensure a high level of face-to-bore perpendicularity. This results in a face runout TIR (total indicated runout) of less than .05 mm (.002") on standard collars with even tighter tolerances on bearing locknuts and special designs. The face-to-bore relationship is important for many applications where components such as bearings need to be properly aligned on the shaft. It also creates even pressure on the interfaced components, prolonging their life, and reduces the likelihood that the shaft collar will shift when it is subjected to shock loads. A circular groove on the shaft collar indicates that it has been single-point faced. Ruland collars should be installed so that the circular groove is on the side that will receive the shock load or against the components that need precise positioning or even pressure.

Ruland shaft collars are offered in aluminum, black oxide carbon steel, stainless steel and engineered plastic. One- and two-piece clamp shaft collars are available with bore sizes from 3 mm to 80 mm in the metric series and from



1/8" to 6" in the inch series. Clamp style shaft collars wrap around the shaft for even distribution of clamping forces. This results in a tight fit and greater holding power, without the shaft damage caused by set screws. Two-piece, clamp-style collars have an additional advantage since they can be installed on the shaft without removing other components. Ruland uses forged socket hardware in all its shaft collars, which allows for higher screw torque and increased holding power. All Ruland

products are RoHS- and REACH-compliant.

### For more information:

Ruland Manufacturing Co., Inc.  
6 Hayes Memorial Drive  
Marlborough, MA 01752  
Phone: (508) 485-1000  
[marketing@ruland.com](mailto:marketing@ruland.com)  
[www.ruland.com](http://www.ruland.com)

## Guide System

ENSURES SMOOTH,  
EVEN SPOOLING

The Amacoil/Uhing GS Guide System helps assure smooth, even spooling by keeping the wire or other material being spooled in line between pay off and take up points. The GS system consists of guide wheels attached to

the end of adjustable arms. The guide is available for Uhing traverse drive models KI3-15, RG3-15-2 and RG3-20-2 and may also be used with non-Uhing traverses.

continued

# product news

Guide wheel arms connect to each other in a modular fashion, permitting combinations of multiple arms, although normal use is with two arms only. The angle of the guide arms relative to each other is fully adjustable, which provides added flexibility in set-up. The GS system may be used with tensioning devices such as dancers; however, the GS itself does not provide tensioning control.

All metal parts are stainless steel, and the GS guide wheels are composite with ceramic groove linings. Ten sizes of guide wheels are available, accommodating wire with outside diameters from 2 to 8 mm (.079" to .315"). Three guide wheel arm lengths—4.62", 6.89" and 9.21"—meet most needs for spooling thin- to medium-gauge materials. The GS guide is assembled before shipping and lists for about \$250 depending on sizes of guide wheels and guide wheel arms selected. Individual parts are also sold separately upon request.

## For more information:

Amacoil  
2100 Bridgewater Road  
Aston, PA 19014  
Phone: (800) 252-2645  
amacoil@amacoil.com  
www.amacoil.com



## Maxon

### EXPANDS MOTOR LINE

Maxon is expanding its existing range of industrial type motors with the addition of two new sizes with IP54 protection rating as well as mounting brakes. The two mechanically

commutated DC motors, with output powers of 200 and 250 watts, are protected on the commutation side with sealed aluminum housing. The cable outputs are sealed with PG cable fittings, and the shaft is secured with a radial shaft seal to guarantee IP54 rating on the flange side. These two industrial versions, with diameters of

50 and 65 mm, are available as standard with various winding options. They achieve nominal torque of up to 0.9 Nm, nominal speeds of up to 5,500 rpm and an efficiency level of more than 90 percent. Low nominal voltage, high power density, a flexible combination range and IP54 protection rating make both power packages suitable for use in



Offset couplings from Zero-Max. This new coupling feature eliminates the need for periodic coupling lubrication and the resulting downtime. These couplings provide precision for parallel offset shafts. They transmit constant angular velocity and torque in a wide range of parallel shaft misalignments.

They are designed for a wide range of machine applications including printing, embossing, paper converting, pharmaceutical and automated assembly systems. The new sealed bearing feature incorporates needle bearings with internal micro-poly

**continued**

industrial equipment, such as automatic dispensing machines, handling and packaging machinery, as well as in battery-operated applications such as electric vehicles, transport and logistics facilities.

**For more information:**

Maxon Motors  
101 Waldron Road  
Fall River, MA 02720  
Phone: (508) 677-0520  
[info@maxonmotorusa.com](mailto:info@maxonmotorusa.com)  
[www.maxonmotorusa.com](http://www.maxonmotorusa.com)

## Zero Maintenance Bearings

AVAILABLE FOR SCHMIDT  
OFFSET COUPLINGS



Zero maintenance bearings are now available as an option for Schmidt



## It's amazing how far you can go with the right travel gear.

You could travel the world and not find a gear manufacturer who combines a range of capabilities, quality and commitment to customer service the way Schafer Gear does. Schafer manufactures gears for many industrial applications including transportation and agricultural equipment. Our gear products range from spur and helical to bevel and worm. And every gear we make comes with one thing standard – prompt, courteous and exceptional service.



**SCHAFER**  
GEAR WORKS, INC.

South Bend, IN/Rockford, IL

Find out more at [schafergear.com](http://schafergear.com)  
or call us at 574-234-4116.

© 2009 – Schafer Gear Works, Inc.

# product news

lubrication. There are no lube fittings, making for a cleaner coupling setup. Compact in design, the couplings keep out contaminants and foreign matter, enabling the couplings to be used in less than ideal operating environments. The Schmidt Offset couplings are designed

to handle parallel offset up to 17 in. and are available with torque capacities up to 459,000 in.-lbs. They impose no side loads on shafts or bearings to eliminate radial shaft vibrations.

#### For more information:

Zero-Max  
13200 Sixth Avenue North  
Plymouth, MN 55441  
Phone: (800) 533-1731  
Zero-max@zero-max.com  
www.zero-max.com

## SKF Bearings

OFFER LESS FRICTION  
AND CONSUME LESS ENERGY

SKF ball bearings for electric motors have been introduced as alternatives to standard bearings by generating significantly less friction and reducing energy consumption. These deep groove ball bearings join a growing family of SKF energy efficient bearing solutions. The bearings exhibit 30 to 50

percent lower friction compared with conventional types and benefit from an optimized design balance between highly engineered internal geometries, grease and bearing cages. Additionally, these bearings promote smooth-running performance and generate less noise and heat. Extended bearing service

life up to double the ISO calculated life can be realized, according to the company's press release. The bearings comply with ISO 15:1998 in a range of select off-the-shelf sizes to allow for interchangeability within existing design envelopes. They can be specified for electric motors up to 37 kW with shaft dimensions up to 60 mm. Custom solutions can be developed to satisfy particular application needs.



#### For more information:

SKF USA Inc.  
890 Forty Foot Road  
P.O. Box 352  
Lansdale, PA 19446  
Phone: (800) 440-4SKF  
skfusainfo@skf.com  
www.skfusa.com

**ONLINE**

**Visit**

[www.powertransmission.com](http://www.powertransmission.com)

**for the latest  
Product News**

## Wittenstein

OFFERS GEARBOX FOR HARSH ENVIRONMENTS



When environmental conditions demand a higher level of protection, the alpha SG stainless steel gearbox from Wittenstein offers a solution. Specially designed for washdown and food-grade environments, this product includes stainless steel housing, stainless steel shaft, stainless steel fasteners, NSF H1-approved food-grade lubricant and custom engineered, corrosion resistant, rotary shaft seals. Applications for this product include food packaging/processing, pharmaceutical manufacturing or wherever clean room or harsh environments are a critical issue. This product is available as standard in sizes 095 and 130. Full technical details and dimensional drawings are available at [www.wittenstein-us.com](http://www.wittenstein-us.com).

### For more information:

Wittenstein, Inc.  
1249 Humbracht Circle  
Bartlett, IL 60103  
Phone: (888) 534-1222  
[info@wittenstein-us.com](mailto:info@wittenstein-us.com)  
[www.wittenstein-us.com](http://www.wittenstein-us.com)

## Bellows

PROVIDE FLEX IN SMALL AMOUNT OF SPACE

BellowsTech edge-welded bellows are designed to provide the most flex in

the smallest amount of space and can be used in vacuum applications as valve stem seals, expansion joints, actuators, vibration dampers and torque couplings. Serving aerospace, semiconductor, high vacuum, oil services, process control and medical device industries, the bellows

**continued**

**AVOID EQUIPMENT BREAKDOWNS.**  
Up to 118,000 ft-lbs.  
FAST REACTING. EASY TO RESET. COST SAVING.

**R+W**  
COUPLING TECHNOLOGY  
THE PERFECT COUPLING  
WORLDWIDE.

R+W America | Phone: (888) 479-8728 | E-Mail: [info@rw-america.com](mailto:info@rw-america.com) | Internet: [www.rw-america.com](http://www.rw-america.com)

# product news

are available in diameters ranging from .394 to 26 in. (10 mm to 660 mm) and in lengths up to 96 in. (24.38 mm). Material thickness ranges from .002 to .036 in. (.05 mm to .91 mm) and includes titanium, 316LSS, AM350 SS, aluminum and Inconel/Hastelloy. All designs are custom and optimized by BellowsTech to meet the customer's specific requirements. Custom metal and precision prototype manufacturing fabrication are also available.

## For more information:

BellowsTech LLC  
1289 N. U.S. Highway 1, Ste. 1  
Ormond Beach, FL 32174  
Phone: (386) 615-7530  
[bellows@bellowstech.com](mailto:bellows@bellowstech.com)  
[www.bellowstech.com](http://www.bellowstech.com)



## Haydon Kerk

### ADDS PROGRAMMABLE LINEAR ACTUATOR DRIVE TO PRODUCT LINE

Haydon Kerk Motion Solutions, Inc. recently introduced the PCM4806 IDEA programmable linear actuator drive. The PCM4806 is the most recent addition to the IDEA Drive family of products. It is optimized to regulate a low current power stage suitable for controlling the smaller Haydon can-stack linear actuators. With the addition of the PCM4806, there's a programmable drive available for use with just about the entire line of Haydon stepper motor linear actuators. The IDEA Drive is a compact, easy-to-use electronic drive and fully programmable control unit with a patent pending graphic user interface. The drive is programmed by use of on-screen buttons instead of complicated command sets or other proprietary programming languages. A unique feature of the graphic user interface is automatic population of the motor and drive parameters based on entering a Haydon actuator part number when prompted by the user interface. Complex parameter calculations or in-depth stepper motor knowledge from the user is completely unnecessary. For a more experienced user, default values



can easily be adjusted as long as they remain within the safe range calculated by the software. The software allows the system designer to troubleshoot programs using line-by-line or multiple-line program execution using the interactive debug feature. Inputs and outputs can also be simulated in software before ever connecting actual I/O hardware.

## For more information:

Haydon Kerk Motion Solutions, Inc.  
Kerk Products Division  
1 Kerk Drive  
Hollis, NH 03049  
Phone: (603) 465-7227  
[info@haydonkerk.com](mailto:info@haydonkerk.com)  
[www.haydonkerk.com](http://www.haydonkerk.com)



## Lee Linear

OFFERS  
CUSTOM-MACHINED  
BALL SCREWS



Lee, a manufacturer of linear motion components, now provides fast turnaround of high-quality, end-machined, precision-rolled ball screws. "Our ball screws maintain their accuracy and quality while remaining cost effective," says Jim Ashworth, vice president at Lee Linear. "Even at high speeds, they offer quiet and smooth operation."

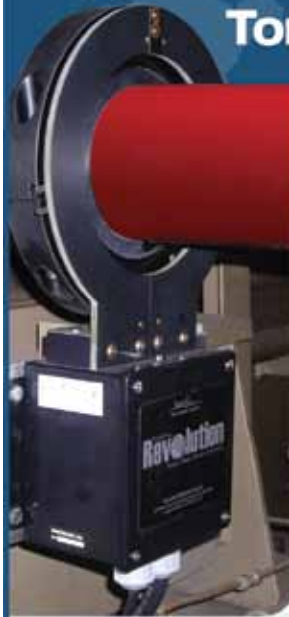
Made from induction case hardened alloy steel, Lee ball screws are integrally sealed and are available in both inch and metric configurations. Suited for close-tolerance work, Lee ball screws and ball nuts are available in regular, high-lead and miniature flange types.

"Selecting the correct ball screw may be challenging," Ashworth says. "Our customers can rely on their Lee representative to work with them to determine the ball screw, nut type, thread length and total length that is best suited for the application."

### For more information:

Lee Linear  
727 South Ave.  
Piscataway, NJ 08854  
Phone: (732) 752-5200  
[www.leelinear.com](http://www.leelinear.com)

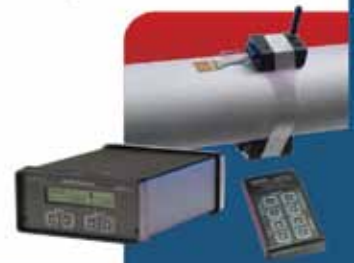
## Need to Measure Real Torque & Power Output?



With Binsfeld systems you can do that. Whether for temporary measurements or continuous monitoring, Binsfeld telemetry instruments deliver *true mechanical* torque and power data direct from the shaft.

- Simple to install - mounts externally to shaft
- Versatile - fits large or small shafts, any torque level
- Accurate - 14-bit digital technology delivers precise, high-resolution data signals
- Non-contact - no wear surfaces means long term reliability

To learn more call 231-334-4383 or contact [sales@binsfeld.com](mailto:sales@binsfeld.com) today.



*binsfeld*  
BINSFELD ENGINEERING INC.

Maple City, MI 49664 • USA • [www.binsfeld.com](http://www.binsfeld.com)  
Phone: (+1) 231.334.4383 • Toll Free: 800.524.3327

Good. Better. Binsfeld.

WE WORK  
HERE



Clifford-Jacobs custom high-strength forgings work everywhere and for some of the biggest names in mining, aerospace, and energy.

So whether you need a 5-pound gear blank or an 800-pound finish machined component, depend on Clifford-Jacobs' uncompromising quality. It comes with fast estimates, ready resources, part warehousing, and zero tolerance for failure.



**CLIFFORD-JACOBS  
FORGING**  
AN IMT COMPANY

[sales@Clifford-Jacobs.com](mailto:sales@Clifford-Jacobs.com) | [Clifford-Jacobs.com](http://Clifford-Jacobs.com) | 888.352.5172 | ISO 9001:2000

## Pressure Transducer

### FEATURES AMPLIFIED OUTPUT

Stellar Technology Inc. offers the new Model FT29XX amplified pressure transducer.

This all-welded stainless steel sensor combines a standard NPT male process connection with a flush diaphragm. In addition, the FT29XX pressure transmitter is designed with internal signal conditioning. Customers can select current outputs, numerous voltage outputs, as well as digital outputs including RS232, RS485, and CANbus. The unique design of the isolation diaphragm reduces stress levels normally

caused by torquing a tapered thread into the mating fitting. The FT29XX introduces zero dead volume to the fixturing and resists the accumulation of residue that can clog traditional pressure ports. The sensing element is machined from a single piece of steel, making the FT29XX insensitive to shock and vibration. This unit is suited for metering and dispensing operations, for the application of sealants and paints, or anywhere a flush diaphragm unit is desired. The FT29XX has an operating temperature range of -65 degrees to 250 degrees F. This compact sensor weighs about eight ounces and delivers a static full-scale accuracy of  $\pm 0.25$  percent (BFSL). Each unit is shipped with a 19-point calibration record, traceable to NIST. The FT29XX integrates with a standard "bayonet"-style electrical



connector. Options include alternative electrical terminations and NPTM pressure fittings.

### For more information:

Stellar Technology Inc.  
237 Commerce Drive  
Amherst, New York 14288  
Phone: (716) 250-1900  
[www.stellartech.com](http://www.stellartech.com)

## AS-Interface Power Conditioner

### DESIGNED FOR EASY MOUNTING

Pepperl + Fuchs recently introduced the VAN-KE2-2PE Two Network AS-Interface Power Conditioner. The VAN-KE2-2PE is the industry's first panel-mount, AS-Interface power conditioner to enable two AS-Interface networks to be operated from a single DC power supply. This power conditioner delivers up to four amps output power per network connection, and is suitable for double master use without the need for data uncoupling.

"Mounting the previous design was often cumbersome, as the AS-Interface connections were located in the base of the G4 housing. This new power conditioner features a KE2 housing that is DIN rail mountable with easy-to-use and color-coded removable terminals for simplified mounting and operation," says Helge Hornis, manager, intelligent



systems group.

Power conditioners are often used in factory or process automation applications where AC power is not available. In such applications, 30 VDC is run to the junction box and connected to the power conditioner, and with the

VAN-KE2-2PE, up to two network segments can be connected there. The ability to make two AS-Interface connections is a powerful option for users because it enables them to power a dual network gateway, both segments before and after a repeater or both

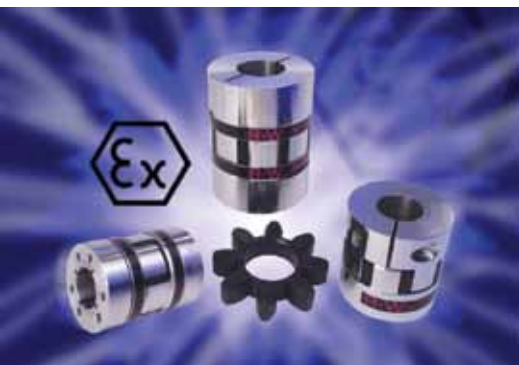
segments after a set of two repeaters. The input voltage is flexible, and the LEDs on the power conditioner's housing light up to provide voltage indication when voltage drops below 28 V and 26 V, respectively.

#### For more information:

Pepperl + Fuchs, Inc.  
1600 Enterprise Parkway  
Twinsburg, OH 44087  
Phone: (330) 486-0001  
sales@pepperl-fuchs.com  
www.pepperl-fuchs.com

## R + W

### OFFERS EXPLOSION-PROOF COUPLINGS



Flexible couplings are a highly critical component when it comes to explosive atmospheres found in automotive paint and cleaning stations, chemical plants, powder mixing areas and numerous other environments. A lack of radially flexible elements in shaft linkage can result in high radial loads being placed on shaft bearings, eventually leading to heat generation and bearing failure, making flexible shaft couplings essential to machine drive design. Even more critical is that the potential for generation of sparks must be eliminated. For use in explosive environments, R+W has

developed a full range of ATEX certified "explosion proof" couplings in accordance with the European directives, ATEX 95 and ATEX 137. These special couplings are precision machined with a thermally and chemically stable, wear resistant, polyurethane insert press fit between the two for zero backlash. A smooth fit between the insert and the hubs helps the insert to compensate for lateral, angular and axial shaft misalignment. The insert is impregnated with graphite, giving it electrically conductive properties, thereby eliminating the potential for any charges arcing from one hub to the other. Official serialized markings including the part number are required by the directive and are clearly visible on each unit.

These precision couplings are available in a variety of mounting configurations, and can include torque overload protection. There are nine total sizes ranging from torque ratings of 2–2,150 Nm (17 to 19,000 in-lbs). Both English and metric bore diameters are available in a range from 3–80 mm (1/8 to 3.125 in) with or without keyways.

#### For more information:

R+W America L.P.  
1120 Tower Lane  
Bensenville, IL 60106  
Phone: (630) 521-9911  
info@rw-america.com  
www.rw-america.com

## Onvio

### ADDS TO REDUCER PRODUCT LINE

Onvio LLC, a U.S. manufacturer of high-precision gearboxes, "zero backlash" cycloidal reducers, and timing belt pulleys/sprockets, announced the newest addition to its family of precision gearbox products. Proprietary gear technology provides efficiency as well as exceptionally smooth and quiet operation, according



to the company's press release. They are designed for demanding applications in packaging, conveying, food processing, printing/converting, machine tool and industrial automation.

The new SL, RL, and FL right-angle gearbox family consists of a 1:1 spiral bevel input module and a precision planetary output stage to develop ratios from 3:1 up to 100:1. Available in four frame sizes with output torque ranging from 6 Nm up to 100 Nm and backlash as low as 12 arc minutes. They are easily mounted to any NEMA or Metric/IEC servo or stepper motor.

Customers can include Onvio's PL flange to integrate the reducer body "within the output timing pulley," resulting in a compact planetary product when machine space is at a premium.

#### For more information:

Onvio LLC  
20 Northwestern Drive  
Salem, NH 03079  
Phone: (603) 685-0404  
www.onviolc.com

## Nord Gearmotors

### HELP TRACK THE SUN

Nord DriveSystems motors have been selected to position and hold solar panels on photovoltaic plants in Northern Germany. Energy efficiency was a deciding factor as the solar panels track and follow the sun over the course of a day. Intelligent tracking technology from Solarpark Rodenäs GmbH increases the efficiency of photovoltaic plants and requires robust gearmotors in order to position and securely hold solar modules against strong winds. Commonly available drive units use conventional brakes and require heaters to prevent them from freezing. These are cost- and maintenance-intensive components that also increase the energy consumption of the system. The gearmotors from Nord fulfill the requirements for weather-resistant, energy-efficient components.

The tracking control data for sunrise and sunset is calculated on a daily basis. At sunrise, the solar panels turn to the east in order to track the sun over the course of the day. Every 15 minutes, Nord's gearmotors are activated by an impulse from the central control unit to track the sun for four degrees and then switch off again. Due to the tracking, the solar collectors achieve a 25 to 30 percent greater efficiency compared to fixed collectors.

The gear units from the modular Flexbloc series that combine two worm gear units hold the panels in position without additional brakes. They position the panels precisely and firmly against winds which often exceed 60 mph. More than 700 geared motors



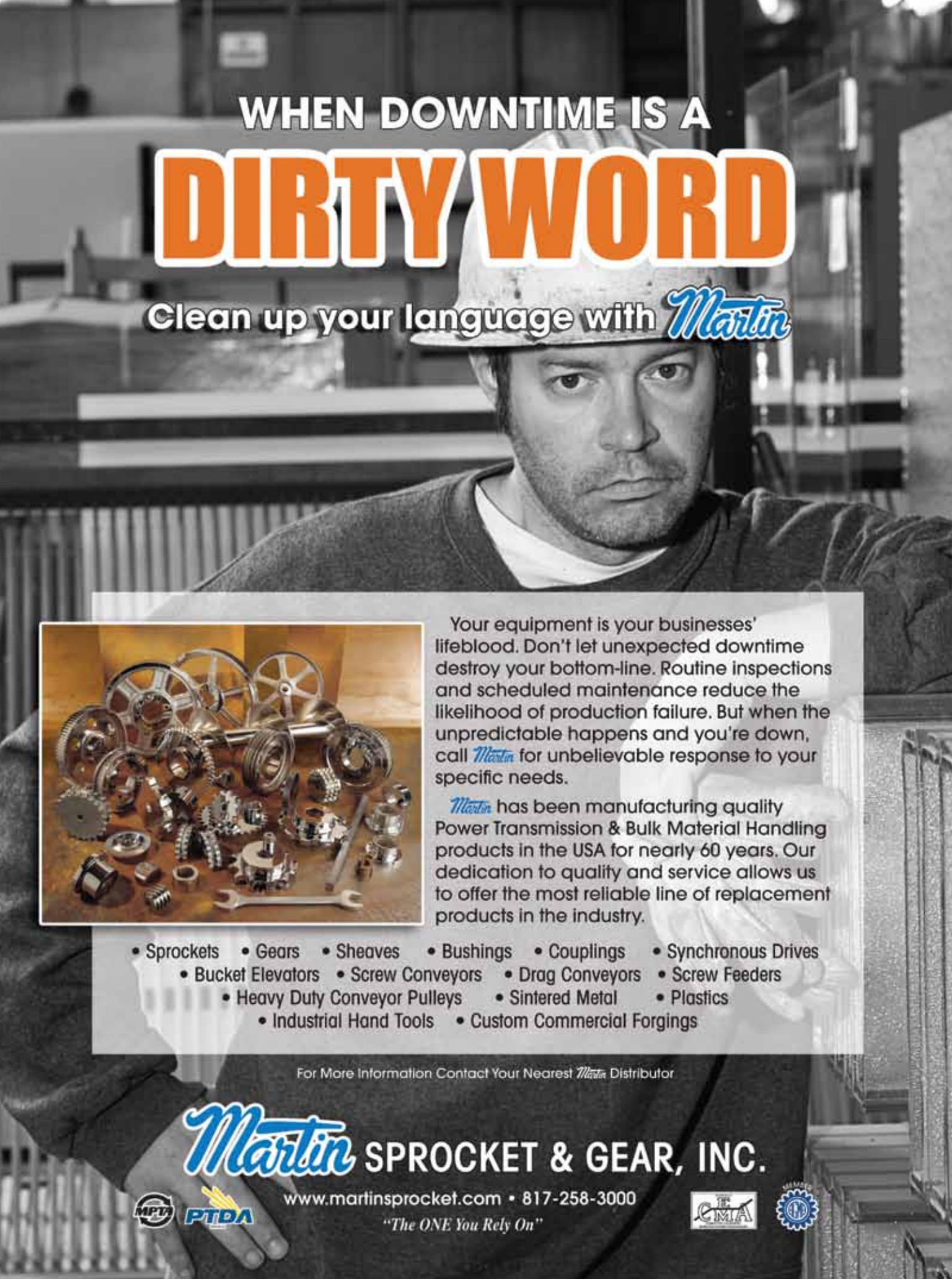
are doubly protected from the harsh North Sea climate by the corrosion-resistant, one-piece aluminum housing and special paint. A high quality synthetic lubricant ensures reliability even at sub-zero temperatures and minimizes maintenance, according to the company's press release.

#### For more information:

Nord Gear Corp.  
800 Nord Drive  
Waunakee, WI 53597  
Phone: (608) 849-7300  
Fax: (608) 849-7367  
[www.nord.com](http://www.nord.com)


# WHEN DOWNTIME IS A **DIRTY WORD**

Clean up your language with *Martin*



Your equipment is your businesses' lifeblood. Don't let unexpected downtime destroy your bottom-line. Routine inspections and scheduled maintenance reduce the likelihood of production failure. But when the unpredictable happens and you're down, call *Martin* for unbelievable response to your specific needs.

*Martin* has been manufacturing quality Power Transmission & Bulk Material Handling products in the USA for nearly 60 years. Our dedication to quality and service allows us to offer the most reliable line of replacement products in the industry.

- 
- Sprockets • Gears • Sheaves • Bushings • Couplings • Synchronous Drives
  - Bucket Elevators • Screw Conveyors • Drag Conveyors • Screw Feeders
  - Heavy Duty Conveyor Pulleys • Sintered Metal • Plastics
  - Industrial Hand Tools • Custom Commercial Forgings

For More Information Contact Your Nearest *Martin* Distributor

*Martin* SPROCKET & GEAR, INC.

[www.martinsprocket.com](http://www.martinsprocket.com) • 817-258-3000

"The ONE You Rely On"





# Helical Gearing Offers Green Alternative

UPGRADING TO GEARBOXES WITH  
HELICAL GEARING CAN SAVE ON ENERGY,  
MAINTENANCE AND LANDFILL SPACE

Stober Drives

**T**he goals of any factory operation are to achieve profits—through cost savings and efficiency.

A long life for equipment results in lower equipment costs; reduced downtime and maintenance means lower operating costs; and low energy consumption equates to lower operating costs.

U.S. manufacturers need to modernize assembly lines in order to revive manufacturing here and compete in the global economy, says Peter Feil, vice president at Stober Drives, Inc. in Maysville, Kentucky. Yet today, Stober estimates that half of U.S. manufacturers still use outdated gearing technology that is low-cost, but inefficient and wears quickly, which wastes energy and causes premature failures.

Feil says helical gearing helps manufacturing go green by preventing breakdowns, saving energy and landfill space—and greatly improving the bottom line in U.S. factories.

“As we rebuild U.S. manufacturing and create jobs, productivity is the key to competing against low-wage labor markets. Highly productive and efficient equipment saves money, energy, materials and time,” says Feil. “Going green in manufacturing is no longer an optional, feel-good choice; it is sound business and our opportunity to regain our competitive edge in the global economy.”

As for the need to modernize assembly lines, there are endless miles of conveyors and tons of equipment that are being driven by inefficient motors and even more inefficient gear drives. “More efficient motors are now required by law, but gear reducers have been virtually ignored by our legislators,” says Feil. “Many of these inefficient gear reducers use outdated worm and spur gearing, not helical gearing. We’ve done energy audits and find that many factories and processing plants are operating equipment at 60 to 70 percent efficiency, which is like driving your car with the parking brakes on.”

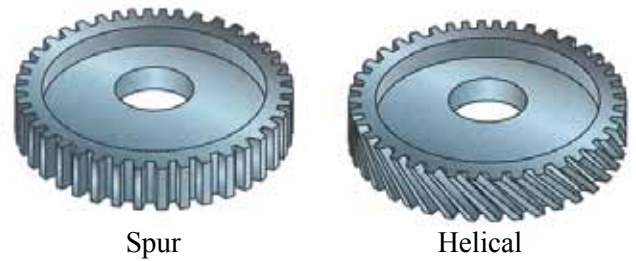
According to Feil, there are two common quality indicators in gearing that all engineers understand intuitively: high noise and vibration, and high heat generation.

**High noise + vibration = low precision and limited life.** Rotating machines that generate high noise and high vibration can have any number of quality issues: rotating components may not be balanced properly, which causes vibration; mating components may be machined to tolerances that are not precise enough regarding perpendicularity, concentricity and true position; or components may not be rigid enough, flexing under load, which can result in misalignment.

**High-heat generation = low efficiency and wasted energy.** High-heat generation is always the result of low efficiency in rotating machines, which can also have many causes, including inefficient design, misalignment, incorrect fits and large seal diameters creating drag.

Unfortunately, says Feil, low-quality gear reducers are a major contributor to industry downtime, maintenance problems and excessive energy consumption. For example, many American factories still have maintenance personnel named “oilers,” whose job it is to check the oil levels in gear boxes and refill them if they are low. These gear boxes often have drip pans underneath them to catch oil as it leaks out. These gear boxes are typically so hot you cannot keep your hand on them for more than a second or two.

The angled teeth of helical gears result in smoother transmission and less noise and vibration.



“Why do so many machine manufacturers use inferior gear reducers on machines that they sell to valued customers?” Feil asks. “Is it the American ‘throw-away’ mentality? Buy at the lowest possible cost and replace it whenever it fails? Of course, the initial cost of a machine is very important, but it is not the only factor that is important to the customer who hopes to run the machine for 10 to 15 years of high productivity, with few or no repairs. Manufacturers should go green just like every other industry has over the past few years. And when they do, they’ll find that as efficiency rises, so do profits.”

One example of green gearing is the evolution of gears from the use of inexpensive-yet-inefficient spur and worm gears to high-efficient helical gears over the last decade. Worm gears operate mainly by sliding contact, resulting in high friction. Spur gears operate mainly by rolling contact,

**continued**

Stober helical gearing is at least 95% efficient.



# Recipe for a Green Gearbox

All Stober helical gearing is at least 95 percent efficient, according to company literature.

Stober helical gearing is machined with angled teeth, then hardened and ground, which is a complex but necessary process to achieve the high-efficiency gear mesh. “The teeth are cut across each gear at an angle, such that the gears gradually mesh,” says owner Bernd Stober. “Because of the angled teeth, two or three teeth of each gear are always in contact with other gears. This alleviates the load on each tooth and creates a smooth transition of forces from one tooth to the next. The result: less vibration, wear, noise and a longer life.”

Quieter gears mean good news for employee hearing, human resources departments and Occupational Safety and Health Administration (OSHA) officers, too.

Stober gears are designed to be nearly maintenance-free; the tooth profiles are designed to minimize gear wear; and since units are packaged in sealed, oil-filled housings, there are no oil changes required, which is another boon for the environment, says Peter Feil, VP of Stober Drives Inc.

Stober helical gear reducers come in many shapes, sizes and configurations, allowing machine designers to eliminate parts with high wear and high maintenance such as belts, pulleys, chains and sprockets. Factories can then assign highly-skilled maintenance staff to modernize equipment rather than repair outdated machines.

Other critical components of helical gearing include housings, lubrication, seals and bearings.

## Housings

Many gear reducers are designed for ease of assembly or for highly-automated assembly, Feil says. “This does lower the overall cost slightly, but it can greatly compromise the integrity of the housing of the gear reducer and adversely affect the quality. These compromised designs have additional plates and gaskets that are then bolted together to form the housing. The result is that these housing assemblies flex, causing gear misalignment, noise, vibration and limited life.”

Rigid, one-piece housings may make gear reducer assembly more difficult and a bit more expensive, but resultant housing stiffness and rigidity keeps shafts and gears precisely aligned, even at high loads. “Additionally, housings must be machined to very tight tolerances to ensure the optimal radial meshing of the gears, as well as the optimal perpendicularity of gears to each other,” Feil adds.

## Lubrication

Inefficient gearing generates high heat losses that in turn elevate pressures inside the gear reducers that require venting to the outside environment. Venting lets air out,

but it also lets air in. Incoming air contains contaminants and adds moisture, which breaks down the oil inside the gear reducers.

“Stober helical gearing, because it is very efficient and does not generate much heat, allows gear reducers to be completely sealed, preventing moisture and contaminants from entering the oil chamber and breaking down the oil,” says Feil. “Oil, under normal operation, should not break down and should not need to be changed for the life of a Stober helical gear reducer. Mineral oils are perfectly adequate for many applications.”

Synthetic oils, for some very demanding applications such as continuous operations or high-ambient temperature environments, may be required to achieve the Stober “lubed for life” performance over many years.

## Seals

Seal surfaces run at high speed against metal surfaces, thus making them the wear items that typically determine the life of a gear reducer. The highest-quality designs, materials and handling and assembly practices are required to ensure that oil seals perform to the level required for long-life gear reducers. “Stober uses the highest-quality seals available from the industry-leading supplier, without compromise,” says Feil. “Preparation of the metal running surfaces that mate with seal lips is also of utmost importance. Machining and grinding of these surfaces to ensure proper seal run-in and operation are just as important as the seal choice.”

## Bearings

Bearings, whether roller, taper or cylindrical, are the other wear items within gear reducers with high-speed metal-to-metal rolling contact under various load conditions. Proper selection and sizing, correct handling and assembly are all critical in ensuring long life in gear reducers.

“The temptation to cut corners to lower initial cost is always present,” says Feil. “Price competition in the market is fierce. Many companies attempt to lower costs in areas that result in a compromise of quality, although that was surely never part of the intent. Stober believes that cost control has to be in other areas like efficiency, waste reduction and continuous improvement, but the quality and durability of the gear reducers should never be compromised.”

The initial cost of Stober helical gearing is somewhat higher than the cost of worm and spur gearing, Feil admits, but that investment is returned many times over during the life of the machine. Stober helical gear reducers are built to order and serviced in the United States. Stober credits its friendly customer service and hardworking Kentucky work force as a leading reason it has experienced continued strong growth since setting up shop there in 1991.



which is more efficient, but the teeth are cut straight across on a face; one or two teeth at a time are in contact with the mating gear, which creates lower load capacity and higher noise compared with a comparably sized helical gear set, says Bernd Stober, owner and former helical gearing designer at Stober.


“The right solution is to utilize high-quality gear reducers utilizing the best technology available, at a competitive price,” says Stober. “Then you will have gear reducers that run cool and quiet for many years versus ones that need to be replaced after the warranty period expires in one to two years.”

As with most complex products in manufacturing, there is not one single thing to point to that passes the litmus test of green manufacturing. Rather, it is an accumulation of careful attention to many details, with uncompromising commitment to quality that makes the difference between functional-yet-inefficient versus high-quality, sustainable gearing.

“Leadership in gearing technology requires the best people in the industry—with years of experience and a spirit of innovation and continuous improvement,” says Feil. “Next, you must utilize only the best materials, processes, tools and the highest-precision equipment available.”

“Helical gearing is 20 to 35 percent more efficient than worm gearing, depending on the ratios and the loading,” Feil says. “Even for a one-HP motor running in a 24/7 operation, that can mean hundreds of dollars per year in energy savings. Since energy costs vary from region to region, and every application is different, we like to demonstrate to customers the actual savings on the customer’s own equipment—in side-

by-side comparisons—to competitor gear reducers.”

“Helical gearing lasts 10-plus years under normal operating conditions,” Feil adds. “Many Stober helical gear reducers have been running for over 20 years.” 

### For more information:

Peter Feil  
Vice President  
Stober Drives, Inc.  
(606) 759-3626  
pfeil@stober.com  
www.stober.com



**Hit Your Target with  
Power Transmission Engineering®  
and [powertransmission.com](http://powertransmission.com)**

### Our Subscribers

- **67.5%** of *PTE* subscribers recommend, specify or purchase **BEARINGS**.
- **60.4%** of *PTE* subscribers recommend, specify or purchase **GEAR DRIVES**.
- **73.2%** of *PTE* subscribers recommend, specify or purchase **GEARS**.
- **55.1%** of *PTE* subscribers recommend, specify or purchase **MOTORS & CONTROLS**.

**Download  
our  
2011  
Media Kit  
At**

[www.powertransmission.com/mediakit.pdf](http://www.powertransmission.com/mediakit.pdf)



The Thanet Offshore Wind Farm is currently the largest offshore farm operating in the world (courtesy of Vattenfall).



The Thanet project was completed in September 2010 and will boost offshore capacity by 30 percent (courtesy of Vattenfall).

# Coastal Question Marks

## DOES NORTH AMERICA'S RENEWABLE ENERGY SOLUTION LIE OFFSHORE?

Matthew Jaster, Associate Editor

**J**ust off England's southeast coast, more than 100 Vestas V90 wind turbines are generating electricity equivalent to the annual consumption of 200,000 British households. The Thanet Offshore Wind Farm, completed in September 2010 by Vattenfall, the fifth-largest generator of electricity in Europe, will provide a significant increase of green energy to the U.K., boosting offshore wind capacity by 30 percent. It's currently the largest offshore wind farm operating in the world.

British Secretary of State for Energy and Climate Change Chris Huhne participated in the September opening ceremony for the Thanet project. "We are in a unique position to become a world leader in this industry. We are an island nation and I firmly believe we should be harnessing our wind, wave and tidal resources to the maximum. I know that there is still more to do to bring forward the large sums of investment we want to see in low carbon energy in the U.K., and we as a government are committed to playing our part," he said in a press release.

The time, money and resources being spent on offshore wind projects in Europe and Asia—40 projects operating in 10 countries—have spurred more dialogue on the role offshore wind energy could soon play in North

America. The catastrophic effects of the Gulf oil spill and the continual reliance on fossil fuels here in the United States suggest other energy options still need to be explored.

### **The Benefits Offshore**

According to the American Wind Energy Association (AWEA), offshore wind turbines generate more power than their onshore counterparts thanks to higher wind speeds and steadier streams. Larger turbines are more feasible offshore, capturing more wind while being able to generate energy near more densely populated areas. The U.S. Department of Energy found that 54 GW of the 300 GW envisioned by 2030 could be found offshore. These developments could spur manufacturing, assembly and transport activities in coastal cities and provide various green jobs to the manufacturing sector.

Since 2009, ten countries have had wind projects installed offshore including Belgium, China, Denmark, Finland, Germany, Ireland, the Netherlands, Norway, Sweden and the United Kingdom. A crucial element in sustaining renewable energy in North America will be the continuous push for projects that include smaller renewable energy segments such as offshore and community wind.

While the current administration has supported many of these renew-

able energy initiatives, more needs to be done. A recently released report, "Untapped Wealth: The Potential of Offshore Energy to Deliver Clean, Affordable Energy and Jobs," by Oceana, an international conservation group, sees much more potential for this area of wind energy.

Jacqueline Savitz, Oceana senior campaign director, recently said in Washington D.C. that "Harnessing offshore wind power in Atlantic waters is a much more cost-effective way to generate energy than oil and gas drilling. If we can get more energy for less money, create more jobs and protect our environment from spills, why not choose offshore wind over oil and gas?"

Oceana says that the offshore investments it has recently proposed to Washington could produce 30 percent more electricity than economically recoverable offshore oil and gas. The group believes offshore wind in Massachusetts, North Carolina, Delaware, New Jersey, Virginia and South Carolina could completely reduce the need for fossil fuels in some states while replacing some of the demand in others. The report recommends the United States eliminate federal subsidies for fossil fuels and redirects such efforts into renewable energy development and energy efficiency programs

**continued**



Ten countries, including England have installed offshore wind farms since 2009 (courtesy of Vattenfall).

immediately. It goes on to argue that offshore drilling for oil and gas should be stopped and that the time has come to make the tax credit for wind energy permanent.

#### **Offshore Wind: Prospects and Politics**

Companies already involved in wind energy or those considering the market might want to keep a close eye on offshore wind in the coming years. Most of the wind energy parts for offshore farms are currently being made overseas in Germany and China. Getting the necessary parts in a timely fashion could prove difficult unless U.S. manufacturers become more involved in this wind segment. Though several offshore farms are in the planning stages, only Cape Wind in Nantucket Sound has received final approval and is scheduled to complete construction in 2012 (*Ed.'s note: See sidebar on page 27 for more information on U.S. offshore projects*).

The real question is what's taking so long? The "Development Plan on Emerging Energies" report out of China was released in July 2010. The report outlines wind production goals

through 2020 by the Chinese government, stating that offshore wind power is expected to reach 30 gigawatts and coastal provinces were required to start drafting offshore business models. In the next three to four years, 514 MW could be installed along the China coastline. According to the report, 17 MW have been installed already.

"China is open for business and it's now the most attractive market for clean energy businesses—which means our jobs could go overseas," Denise Bode, CEO of AWEA, recently said. "Over the last few years, we've seen new factories and wind farms grow here at home. And we know that clean energy technology can continue to be one of the bright spots in the U.S. economy."

*The New York Times* recently reported that the booming Chinese clean energy sector, now more than a million jobs strong, could grab hold of these technologies and never let go. As the world's population grows by nearly a third, to nine billion people by the middle of the century, North America will need to remain focused on clean energy as coal and oil reserves all but disappear.

*The New York Times* goes on to say that much of China's clean energy success lies in aggressive government policies that help this crucial export industry in ways most other governments do not. These measures risk breaking international rules to which China and almost all other nations subscribe, according to some trade experts.

In Washington, renewable energy is a highly-contested and politically-charged chess match between Republicans and Democrats. Instead of addressing the energy issues, specifically the oil spill and North America's energy future, political candidates continue to argue back and forth for votes.

In response to rhetoric flying around Washington that a renewable energy standard would actually increase electricity prices, Bode of the AWEA said, "As a top official in charge of keeping electricity rates low in Oklahoma, the wind projects I approved saved consumers more money while protecting consumers from the risk of volatile fuel prices of conventional generation."

The AWEA, in fact, published some facts on its website to rebut some

of the recent talk on Capitol Hill. The organization says more renewable energy through a national RES (renewable energy system) will lower fuel prices, stabilize electricity rates and shield rate-payers/consumers from fuel price spikes and regulatory risks.

Independent studies from the U.S. Energy Information Administration (EIA) found that an RES could save consumers anywhere from \$400 million to \$2 billion. The EIA has also found that a national RES would lower natural gas and coal prices and often lower electricity prices. Policies and price signals, according to AWEA, however, do not fully recognize the value of electricity generated with zero-emissions. Without a long term renewable energy policy the demands for clean energy will probably not be met.

In late September, an RES bill was introduced by Senators Bingaman, Dorgan and Collins and applauded by the AWEA in a statement: "This bill comes at a time when Americans need jobs and more clean energy resources. And wind energy can create jobs and clean energy right here at home."

Hopefully, U.S. manufacturers of bearings, gear drives and other wind components will reap the benefits of a long-term renewable energy strategy. As has been the case for many years, those invested in wind energy projects in the United States must wait on Washington while Europe and Asia continue to move forward on offshore wind production.

Meanwhile, the debate on the benefits of wind energy, particularly offshore wind farms, is far from over. Detractors argue that tougher weather conditions mean limited access to routine maintenance. Others say that the saline environment creates the need for longer-lasting, more robust parts, which in turn means more money. Homeowners near and around proposed offshore sites worry that these wind farms might harm ocean views.

Though some environmentalists still worry about the natural impact of offshore wind, the AWEA says that offshore turbines can create artificial reefs and that extensive studies in Europe have revealed no significant bird impacts and that for the most part,

continued

## Better Late Than Never

With 40 offshore projects in operation in Europe and Asia, North America is a little late to the party. But that doesn't mean that there aren't several farms in various stages of planning. Here's a brief rundown of some current and upcoming offshore wind projects in the United States:

**Cape Wind, Nantucket Sound.** The United States' first offshore wind project, Cape Wind, received final approval in April 2010 and is scheduled to complete construction in 2012. Built in Nantucket Sound, Cape Wind will feature 130 wind turbines producing up to 420 MW of clean, renewable energy. Cape Wind is currently the only offshore project that is past the planning stage. The project's website, [www.capewind.org](http://www.capewind.org), states that the offshore wind farm will provide renewable energy capable of replacing 113 million gallons of oil per year, stabilize Massachusetts electricity prices and conserve and help lower natural gas costs. The jobs gained from environmental, geological and oceanographic studies, 18-plus months of construction and the jobs needed to maintain, monitor and operate the wind farm present further economic advantages. More importantly, it boosts the manufacturing technology sector, allowing Cape Cod to build more state-of-the-art facilities to attract even more high-tech engineering and manufacturing jobs.

**Block Island Wind Farm, Rhode Island.** After months of uncertainty, an approval vote in August paved the way for an eight-turbine wind farm off the coast of Block Island. Deepwater Wind, the project developer, hopes to expand with 106 additional turbines in the future. The company has been selected by two states, Rhode Island and New Jersey, to build wind farms offshore. Without visual impact issues, these turbines can be large in scale with zero pollution or dangerous waste. The Block Island Wind Farm hopes to become a 28.8 megawatt offshore wind farm approximately three miles southeast of Block Island consisting of 5-8 turbines. The wind farm will gen-

erate approximately 107,222 megawatt hours annually, supplying the majority of Block Island's electricity needs. Excess power will be exported to the mainland. Deepwater plans to commence site preparation in late 2010 and to commence commercial operations in 2012.

**Mid-Atlantic Wind Park.** NRG Bluewater Wind is currently developing projects in Delaware, Maryland, New Jersey, and New York. The company has responded to numerous requests for proposals and requests for information in these states as well as Rhode Island and North Carolina. It is also exploring projects in the Great Lakes and Canada. The NRG Bluewater Wind projects are in various stages of development.

**Great Lakes Wind Farm.** The Lake Erie Energy Development Corporation (LEEDCo) has recently selected a team of companies to develop an offshore wind farm on Lake Erie. It will be the first offshore wind farm built on a fresh water lake in North America. The initial project will see a five-turbine 20 MW pilot plant set up on the lake some 8 km to 16 km from the city of Cleveland. This is expected to start generating electricity by late 2012. LEEDCo says it could see the development expanded to as much as 1 GW of generating capacity by 2020.

**Northern California.** Researchers have been looking at a specific area in Northern California for possible offshore distribution. They've found that a wind park at Cape Mendocino would supplant about five percent of California's electricity coming from carbon-emitting sources. When combined with offshore wind energy at several other sites, it may be possible to produce between at least a quarter—and potentially all—of California's electricity. Though the transmission lines available to deliver such power are found in the southern part of the state, Pacific Gas and Electric Co. is looking into building new transmission lines in Northern California. For more information on offshore wind potential in North America, visit [www.awea.org](http://www.awea.org).

# McINNES ROLLED RINGS

Fast Quotes  
Fast Deliveries  
4" -72" Diameters

Carbon,  
Alloy &  
Stainless

1-2 Week  
Deliveries\*

\*with material in stock

1-800-569-1420

www.mcinnesorledrings.com  
sales@mcrings.com



The Lillgrund Wind Farm off the coast of Sweden is the third largest offshore farm in the world (courtesy of Vattenfall).




A visual simulation of how Cape Wind in Nantucket Sound would appear from a boat at a distance of one mile (courtesy of Cape Wind).

birds avoid wind farms altogether.

Shipping routes are a growing concern, however, particularly around the U.K. With each and every new offshore proposal—and there are plenty out there—shipping companies raise concerns that routes will be altered. Also, there are still skeptics that don't believe the promised energy savings from wind, offshore or otherwise, can actually ever be achieved.

As the debate continues on wind energy in North America, there are at least some positives in the power transmission community. According to the Power Transmission Distributors

Association's (PTDA) quarterly business index, the power transmission/motion control industry experienced rapid growth during the second quarter of 2010. Manufacturers are expanding at a rapid rate and distributors posted a much higher growth index than previous years. The survey anticipates that this momentum will continue into 2011. One wonders how big a role renewable energy might play for the power transmission community in the future. 

# High- Performance Industrial Gear Lubricants

FOR OPTIMAL RELIABILITY

**K.G. McKenna, J. Carey, N.Y. Leon and A.S. Galiano-Roth**

*(Printed with permission of the copyright holder, the American Gear Manufacturers Association, 500 Montgomery Street, Suite 350, Alexandria, Virginia 22314-1560. Statements presented in this paper are those of the author(s) and may not represent the position or opinion of the American Gear Manufacturers Association.)*

## Management Summary

In recent years, gearbox technology has advanced and original equipment manufacturers (OEMs) have specified required gear oils to meet the lubrication requirements of these new designs. Modern gearboxes operate under severe conditions while maintaining their reliability to ensure end-user productivity. The latest generation of industrial gear lubricants can provide enhanced performance—even under extreme operating conditions—for optimal reliability and reduced cost of operation.

This paper describes how gear lubricants function in gearboxes and discusses the facts versus myths of industrial gear lubricants. The paper will show how advanced gear lubricant technology can optimize the life of the gears, bearings and seals. Opportunities to use advanced synthetic gear lubricants to achieve operational benefits in the areas of improved energy efficiency, wider operating temperature ranges, extended oil drain intervals and equipment life will be discussed.

## Types of Lubricating Film Classifications

Knowledge of the types of lubricating film will assist in understanding the formulation and application of gear lubricants.

The two types of lubricating film relevant to gear lubri-

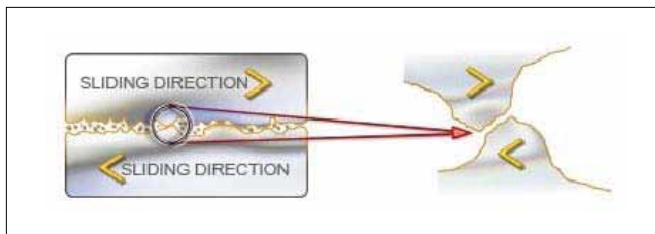
cation are boundary and elastohydrodynamic lubrication (EHL). Understanding the characteristics of each is important in understanding the lubricant performance requirements.

**continued**

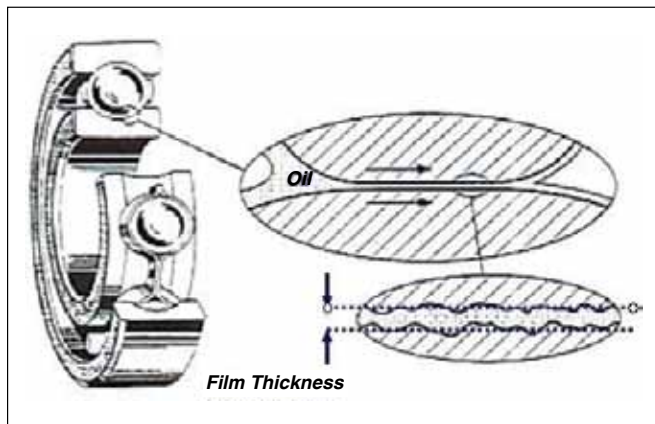
Figure 1 shows that boundary lubrication exists during sliding motion where metal-to-metal contact occurs between the two surfaces. The coefficient of friction ranges from 0.1 to 0.15 between the metal surfaces in this lubrication region. In the absence of specialized anti-wear additive technology, increased wear rates will occur during boundary lubrication.

The amount of wear will depend on temperature, speed, surface finishes, material, lubricant viscosity and effectiveness of the additives. Gears operate with combined sliding and rolling motion above and below the pitch line. Under low-speed and high-temperature conditions, the EHL film will be relatively thin and boundary conditions will dominate.

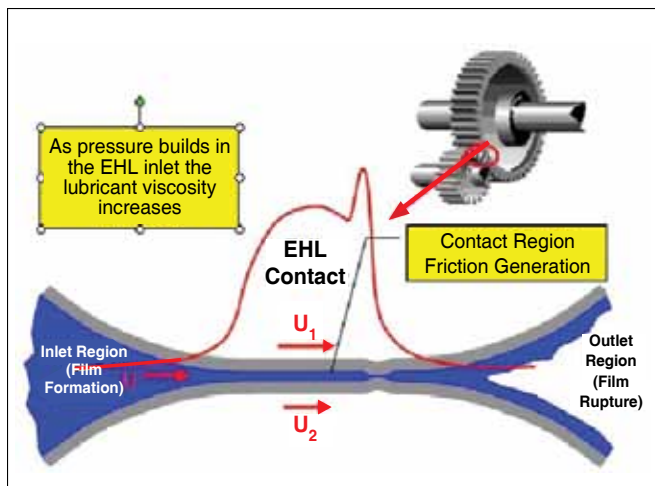
EHL occurs when the lubricant film thickness reduces metal-to-metal contact and local contact pressure between the surfaces is high enough to cause elastic deformation. This creates a small but finite area of contact, often referred to as the Hertzian contact zone. The high contact pressure also acts to increase the lubricant viscosity as it is drawn into the contact zone. This increase in viscosity helps generate



**Figure 1—Boundary lubrication.**



**Figure 2—EHL in bearing.**



**Figure 3—EHL in gears.**

the lubricant film that maintains the separation of the two surfaces. With this high viscosity and the short time in the contact area, the lubricant cannot escape and separation of the surfaces is achieved. The film thickness generated in EHL contacts of this type is very thin and is typically between 0.1 to 0.5 micrometers. Film thickness is a function of temperature, speed, load, geometric conformity of the surfaces, initial lubricant viscosity and the rate at which viscosity increases with pressure. This last characteristic is often quantified by the pressure-viscosity coefficient of the lubricant, and varies with its composition.

Surface finish also influences the state of lubrication between two surfaces. The more polished the surface, the lower the lubricant film thickness that is required to achieve separation between the contacting surfaces. This is often quantified in the Lambda value or specific film thickness. This is merely the ratio of the EHL film thickness to a measure of the combined surface roughness. Thus a high specific film thickness indicates that the surfaces are well separated. Conversely, a low specific film thickness indicates poorer surface separation, which may result in higher friction and potentially increased rates of wear.

Two examples of EHL lubrication classification are when gear teeth mesh at the pitch line and in the load zone of anti-friction bearings (Figs. 2–3).

### Gear Lubricant Requirements

The lubricant formulator must consider many factors and components in developing a proper lubricant for an enclosed gearbox. The most important components are the gears—i.e., gear teeth, bearings and seals. The factors influencing the lubricant and the reliability of the gears, bearings and seals are:

- Gear type
- Gear speed
- Reduction ratios
- Operating temperatures
- Filterability
- Input power
- Load characteristics
  - Shock in a steel mill
  - Steady in a power plant cooling tower
- Drive type
- Application method
- Water contamination
- Ambient conditions
  - Arctic temperatures below  $-20^{\circ}\text{F}$
  - Tropical, high-humidity temperatures above  $100^{\circ}\text{F}$
- Maintenance access
  - Easy access; walk-up to the gearbox
  - Located under an evaporative-type cooling tower
  - Located aboveground in a wind turbine or overhead crane
- Industrial specifications
  - AGMA (American Gear Manufacturers Association)
  - DIN (Deutsches Institut für Normung)
- Original equipment manufacturers (OEM) specifications



The goal is to develop a lubricant that uses high-performance base stocks balanced with the proper additive technology to achieve the optimum performance and reliability of the gearbox.

When gearbox operating conditions are severe, such as extreme temperatures, loads and speeds, synthetic lubricants may be necessary for reliable operation. A synthetic lubricant that offers extended drain intervals may also be desirable where equipment is not readily accessible. An example of an application that meets the preceding criteria would be gearboxes in wind turbines.

### Gear Lubricant Characteristics

The necessary characteristics for a gear lubricant can be stated as:

- Correct viscosity at operating temperatures to assure distribution of the lubricant to all contact surfaces and formation of an EHL film over the range of operating speeds and loads.
- Adequate low-temperature fluidity to permit circulation at the lowest expected start-up temperature.
- Chemical stability to minimize oxidation under elevated temperatures and agitation in the presence of air, and to provide the desired lubricant life for the maintenance service intervals.
- Good demulsibility to permit water separation for removal.
- Good anti-wear performance to protect against wear under boundary lubrication.
- Extreme pressure additives to minimize welding of metals under excessive loads.
- Low traction to control operating temperatures under severe service.
- Anti-rust properties to protect gears and bearing surfaces from rusting.
- Non-corrosive chemistry so that gears and bearings will not be subjected to chemical attack by the lubricant.
- Foam resistance to allow entrained air to separate from the lubricant.
- Compatibility with commonly used seals.

A properly formulated enclosed gear lubricant is a balanced formulation that will provide gear protection, bearing protection, corrosion/rust resistance, seal compatibility, filterability, oxidation resistance and anti-foam/air release (Fig. 4).

### Gear Protection

The gear lubricant functions are to cool, reduce wear and to assist in sealing for optimal protection of the gearbox components. An area of concern for lubricant gear protection is excessive wear. Several types of wear might take place including pitting, micropitting and scuffing.

Pitting can be in the form of micropitting or macropitting. Micropitting is surface metal fatigue that causes tooth profile shape deviations that can reduce gearbox efficiency while increasing noise and vibrations. Two commonly used terms to describe micropitting are “grey staining” or “frosting” of the gear tooth face. Contact stresses located below the pitch line (dedendum) of the driving gear tooth are higher because of the shorter radii of the tooth curvature (Fig. 5).

Gears that are overloaded for any reason will develop

fatigue failure, and pitting of surface metal will occur in the dedendum area after long periods of time. As the pitting increases, it can be called macropitting. If an overload is great enough, this type of fatigue failure could occur in a relatively short period of time (Fig. 6).

Micropitting is talked about more in current gear designs than those of 30 years ago. There are many operational and design factors that increase the tendencies for micropitting. Listed below are potential solutions to reduce micropitting in gears.

### Solutions for reducing macro/micropitting mechanically:

- Use quality steel; properly heat treat to desired hardness.
- Reduce contact stresses by reducing load.
- Optimize gear geometry.
- Polish to smoother surface finishes.
- Assure uniform load distribution.

### Solutions for reducing pitting through lubrication:

- Check to ensure the use of the proper viscosity. Higher-viscosity lubricant directionally may be a solution, but beware that the higher viscosity may cause issues with

continued

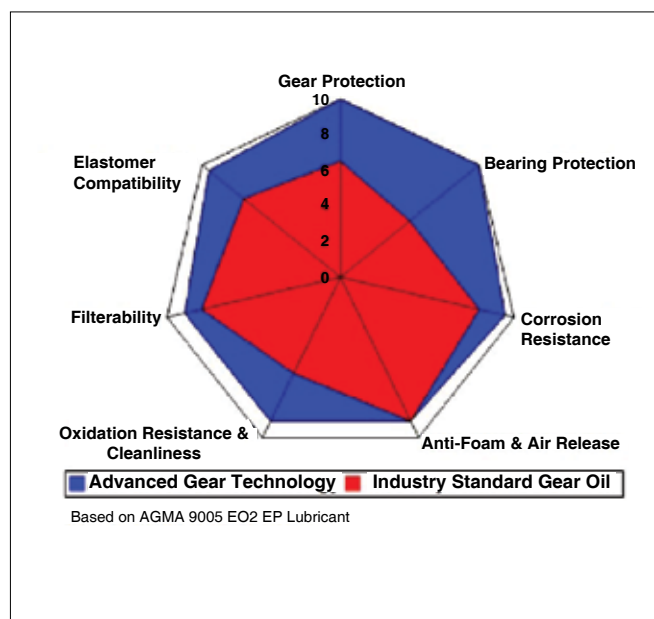


Figure 4—Balanced gear oil formulation.

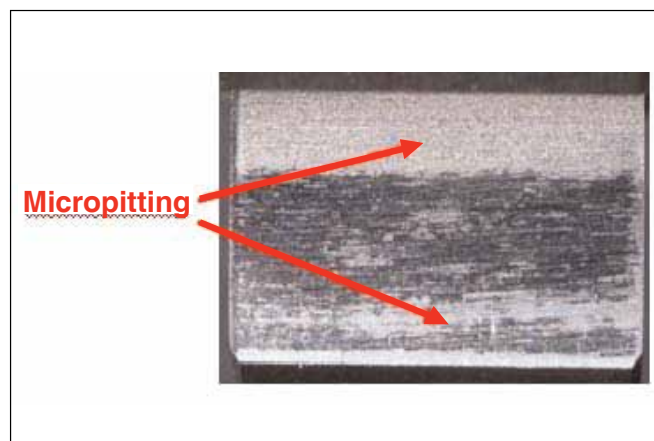


Figure 5—Micropitting example.

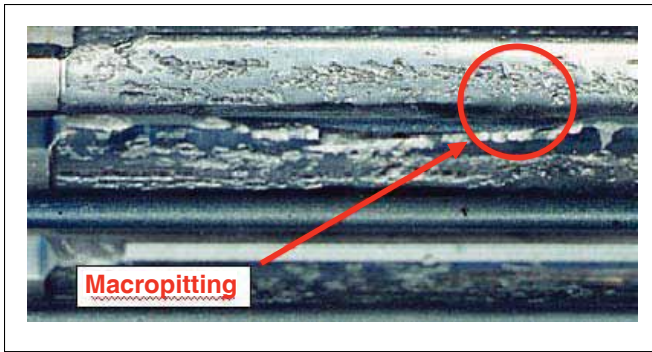


Figure 6—Macropitting example.

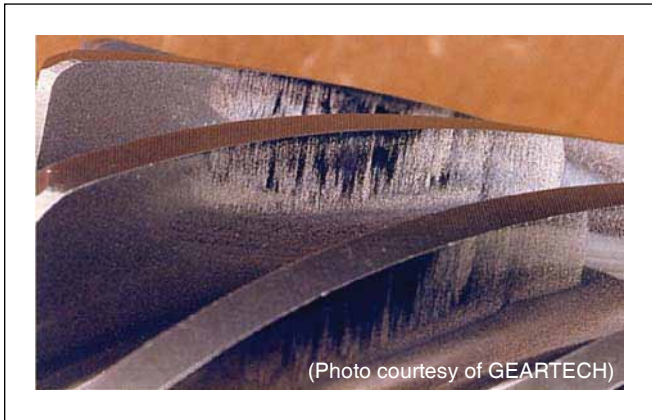


Figure 7—Scuffing.

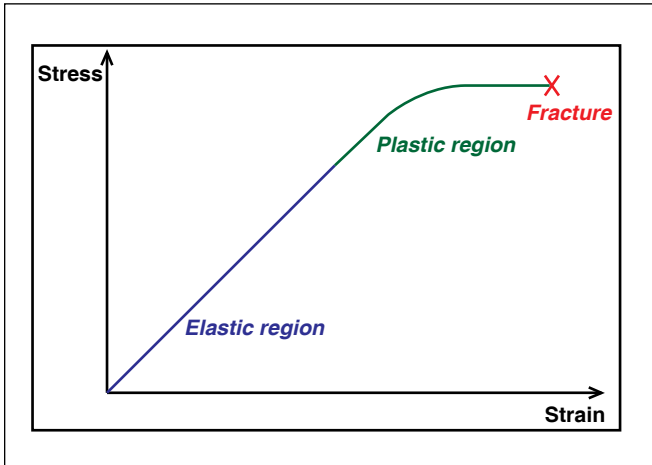


Figure 8—Stress/strain curve.

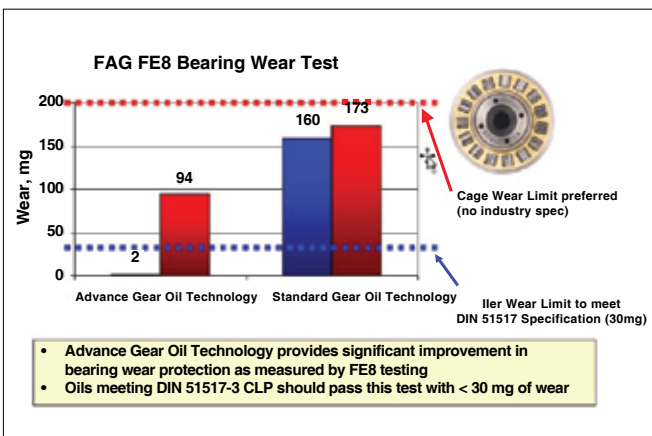


Figure 9—FAG FE8 roller bearing test.

the bearings or other gears in the gearbox.

- Use a lubricant containing micropitting-resistant additives.
- Reduce lubricant operating temperature.
- Use synthetic lubricant to provide higher film thickness at operating temperatures and to reduce shear forces in the sliding-contact area through their inherently lower-traction coefficient versus mineral oil.

Scuffing (sometimes referred to as scoring by users of industrial gear oils) is severe adhesion and metal transfer between teeth due to welding. Under conditions of heavy loads, extreme temperatures, rough and irregular surfaces, loss of or inadequate oil supply, or the use of a lubricant with too low of a viscosity will result in only a partial lubricant film present in the loaded contact area. This partial lubricant film condition causes a degree of metal-to-metal contact between the surfaces that will tear and weld the gear material (Fig. 7). Listed below are potential solutions to reduce scuffing in gears.

**Solutions for reducing scuffing mechanically:**

- Use proper initial starting run-in procedures.
- Optimize gear geometry, use precision gear tooth design and maintain good helix alignment.
- Use smoother surface finishes.
- Use properly engineered materials for maximum scuffing resistance.

**Solutions for reducing scuffing through lubrication:**

- Use the proper viscosity lubricant. Higher-viscosity lubricant directionally may be a solution, but be aware that the higher viscosity may cause issues with the bearings or the other gears in the gearbox.
- Use a lubricant containing anti-scuffing additives; i.e., sulfur, phosphorous or borate.
- Reduce lubricant operating temperature.
- Use a synthetic lubricant to provide higher film thickness at operating temperatures and reduced contact area temperatures through its inherently lower traction coefficients.

Shock loading is a sudden application of excessive loads on the gear teeth, which can result in their plastic deformation. What is plastic deformation of a metal?

When a metal is loaded or stressed, it causes strain and stretches similar to a rubber band when pulling on the ends, but with much less movement to the material.

When a load (stress) is maintained in the elastic region of the material; when the load (stress) is removed, the metal will return to its original size.

However, if the load (stress) exceeds the elastic region of the metal, it goes into the plastic region. When this occurs, the metal does not return to its original size after the load is removed. When the load (stress) exceeds the yield point of the metal, it will fracture (Fig. 8).

Shock loading reduces the life of the gears. It is caused by the operational conditions in the process, which is being driven by the gearbox. Until the shock loads are reduced in

frequency and/or amplitude, the gears will not achieve their optimum life.

**Solutions for reducing shock load mechanically:**

- If the loads are resulting in gear fracture and unscheduled downtime, change operational conditions to reduce the shock loads. Because there is a balance between optimum gear life and maximum production, overall knowledge of the plant operational goals is required.
- Use higher-horsepower-rated gearboxes. (Typically, the user will push the limits of the design to achieve maximum production.)

**Solutions for reducing wear rates caused from shock load effects on gears through lubrication:**

- Loads typically exceed the elastic region of the metal and a higher viscosity cannot “cushion” the force. Therefore, continue use of the proper or OEM-recommended viscosity lubricant to prevent other issues that can occur with a heavier viscosity lubricant.
- Use anti-scuffing additives—i.e., sulfur, phosphorous or borate—to reduce the welding of metal during the shock load.
- You can never reduce a mechanically induced shock load through lubrication.

**Bearing and Seal Life**

When a gear lubricant is formulated, consideration for the bearings and seals is also important. If premature bearing failure occurred, damage of the gears may follow. If the seals are not functioning as designed, or prematurely fail, other concerns may arise. These concerns are increased lubricant consumption and an increased level of detrimental contamination in the gearbox. The contamination results in decreased reliability of the gearbox.

Reports vary, but 40–60% of gearbox failures are initially bearing failures (Ref. 9). The bearing failure modes are micropitting, macropitting and spalling, caused by high surface stresses, abrasive wear and etching/plastic deformation caused by hard particles. Hard particles come from external contaminants, corrosion particles (rust), and wear particles from components in the gearbox. Bearings also fail because of insufficient lubricant or improper lubricant viscosity and/or additives.

A standard test is the FAG (an international roller bearing manufacturer) FE8 roller bearing wear test. This multipurpose laboratory rig test can evaluate friction, bearing wear and the deposit-forming tendency of the lubricant.

As shown in Figure 9, the lubricant using high-quality base stocks and the advanced, balanced-lubricant technology, achieves improved results over the standard gear lubricant technology.

SKF, the international roller bearing manufacturer, has done extensive work to develop a detailed bearing life equation. The equation considers loads, reliability and life-adjustment factors. The life-adjustment factors include the effects of lubrication and external contamination.

$$L_{naa} = a_1 a_{SKF} \left(\frac{C}{P}\right)^{10/3} \tag{1}$$

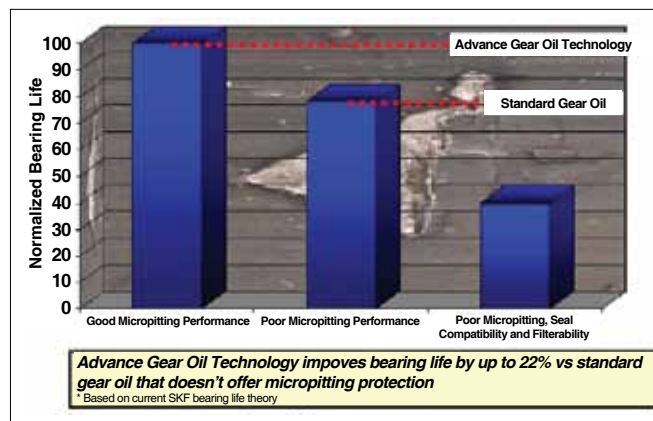
where:

- $L_{naa}$  is adjusted-rating-life in millions of revolutions;
- $a_1$  is life-adjustment-factor for reliability (= 1 for 90% reliability);
- $a_{SKF}$  is life-adjustment factor, including the effects of contamination and lubrication;
- $C$  Basic dynamic load rating, kN (function of bearing type, size, load and speed);
- $P$  Equivalent dynamic bearing load, kN.

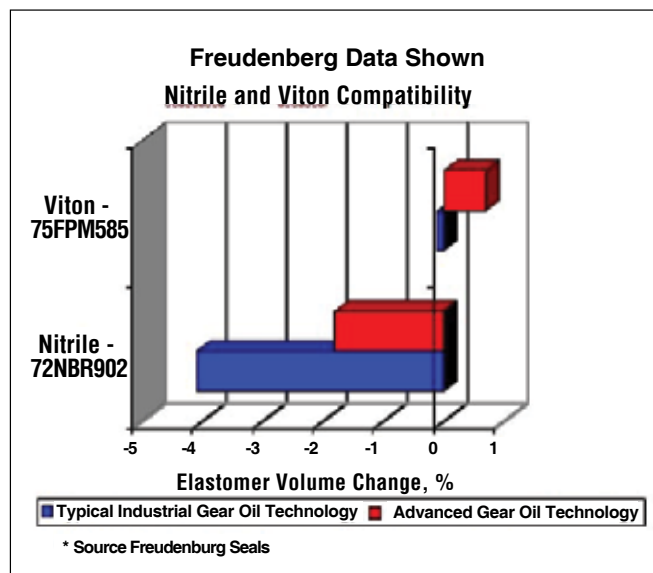
Conclusions from Equation 1 are used to increase bearing life and reduction in wear debris through proper lubrication and reduced external contamination. Figure 10 shows the difference in bearing life.

Seals are important to reduce external contamination in the gearbox but are also a common limiting factor to equipment life. Seals should be selected to ensure compatibility with high-performance gear lubricants. Figure 11 shows the test results of two common seal materials used in gearboxes.

**continued**



**Figure 10—SKF bearing life theory.**



**Figure 11—Seal test results.**

The figures above show the lubricant using high-quality base stocks and the advanced-balance-lubricant technology achieving improved results over the standard gear lubricant technology.

### Oxidation Stability and Corrosion Protection

Oxidation stability is important because as the lubricant oxidizes it will thicken in viscosity and form deposits. Increased viscosity will result in lower efficiencies and higher temperatures in a gearbox. Deposits also cause increased temperatures in a gearbox.

A lubricant containing advanced anti-oxidation technology will have longer oil life in modern gearboxes, versus oils formulated with only conventional gear lubricant additives. This is important because modern gearboxes are designed to operate at higher temperatures than gearboxes of 30 years ago.

Corrosion protection is important because corrosion reduces the life of gears and bearings. Corrosion increases stresses in the contact area of the metals and increases wear debris in the gearbox, thereby decreasing the life of its components. Figures 12 and 13 show oxidation and corrosion test results. These figures show the lubricant using high-quality base stocks and the advanced-balance-lubricant technology achieved improved results over the standard gear lubricant technology.

### Synthetic Gear Lubricants

A synthetic lubricant is formulated with synthetic base fluids. Most synthetic base fluids are products derived from chemical synthesis, which creates consistent uniformity in appearance and performance. Some severely hydro-processed mineral oils, which have undergone chemical rearrangement, are now marketed and recognized as synthetic oils.

Synthetic gear lubricants can be made from many base fluids, each with various properties. Depending on the application, one type of synthetic base fluid may have advantages over other synthetic base fluids and mineral oils. These various base fluids can be PAO (polyalphaolefins), PAG (polyglycols), organic esters, phosphate esters, polybutenes, silicone, fluoro-carbon and others. PAOs and PAGs are common synthetic-based fluids used in industrial gear oils.

#### Features of synthetic lubricants.

Synthetic gear lubricants are proven in the most extreme conditions. They provide enhanced performance versus standard gear oil technology in the areas of:

- Thermal and oxidative stability (Figs. 12–14)
- Low volatility
- Shear stability
- Low-temperature performance
- Improved traction properties (lower energy requirements)

**Properties of synthetic lubricants.** See Table 1 for synthetic gear lubricants with PAO-based fluids, and Table 2 for synthetic gear lubricants with PAG-based fluids. Synthetic lubricants offer the following benefits:

- Synthetic lubricants offer a potentially wider range of operating temperatures.
- Reduced energy requirements. When energy consumption is reduced, waste heat is less. Figure 15 shows the thermographic images on identical gearboxes that result from lower energy consumption.
- Table 3 lists additional benefits of the synthetic lubricant.

#### Comments on Synthetic Gear Lubricants

Synthetic gear lubricants have various benefits that potentially can lower operating and maintenance costs while creating higher revenue through increased production. Synthetic gear lubricants may be the solution to your equipment concerns. An engineering analysis can identify the potential savings and may lower your total cost of ownership (TCO).

#### Balanced Formulations

Industrial gear lubricants are formulated to meet the demands of today's competitive gearbox market. The formulator must consider many factors in developing the gear lubricant. Proper viscosity through high-quality base stocks is still the key factor in performance of the lubricant, and will only be enhanced by the selection of the proper balance of additives.

Today's high-quality lubricants contain many different additives to protect equipment and provide long oil life. Each additive has been designed to offer a particular performance benefit, but with it, more often than not, come detriments to the performance of other lubricant additives. Take rust inhibitors and anti-wear additives for example. These additives work on the metal surface, bonding and interacting with the surface to form a protective film. Figure 16 shows how, individually, (a) a rust inhibitor and (b) an anti-wear

**Table 1—Properties of Gear Lubricants with Polyalphaolefins.**

Viscosity Index	130–160+
Low temperature fluidity	–40°C range
Oxidation and thermal stability	Excellent
Hydrolytic stability - add shear stability	Excellent
Compatibility to mineral oils	Excellent
Compatibility to seals/paints	Good in balanced formulation
Additive solubility	Good in balanced formulation
Traction coefficient	Very good
Viscosities range	Wide range available

**Table 2—Properties of Gear Lubricants with Polyglycols.**

Viscosity Index	200+
Low temperature fluidity	–20/–50°C
Oxidation and thermal stability	Excellent (No Coke)
Hydrolytic stability	Good, but can be hygroscopic
Compatibility to mineral oils	Poor – miscible to immiscible
Compatibility to seals/paints	Fair
Additive solubility	Good
Traction coefficient	Excellent
Viscosities range	Wide range available

additive, form a protective film. However, combining such additives forces them to compete against each other for the metal surface. Incorrect selection of chemistries and/or failure to balance additive concentrations properly can result in one additive dominating the metal surface. The rust inhibitor (c) adequately protects the metal surface, but the anti-wear additive, being blocked from bonding with the surface, is unable to protect the surface from wear. A lubricant formulated in the (c) example would be prone to causing premature equipment failure.

Alternatively, with the right chemistries at the optimum and balanced concentrations, a lubricant can achieve good performance in both features. A balanced, formulated gear lubricant shown in Figure 16d enables both additives to share the surface and thus offers optimum rust and anti-wear protection. The trade-off between rust and anti-wear additives is just one of many formulating hurdles faced by lubricant developers.

Care should be taken when selecting a lubricant to ensure that the best overall balance and optimized performance for the application have been designed into the product. Check that any perceived “extra protection” is appropriate and is not achieved at the expense of other important properties. The selection of an unbalanced lubricant may lead to unwarranted maintenance requirements, downtime and premature equipment failure and higher operating costs.

There are many concerns in formulating an industrial gear lubricant, and a properly balanced formulation is key to productivity. Depending on the application, a synthetic lubricant may be the best choice for your operations.


### Summary of Gear Lubricants

Industrial gear lubricant formulations have changed over the past few years to meet the demands of new gearbox designs. The formulator must consider many factors in the gear lubricant.

An understanding of the lubricating film classifications and their effects on the equipment are required for the properly formulated industrial gear oil. The knowledge of gear types, speeds, operating temperatures, loads, drive type, ambient conditions, maintenance accessibility, industry specifications and OEM specifications are important to the gear oil formulation. This enables the formulator to achieve the correct lubricant characteristics to optimize gear protection in the application.

It is equally important to formulate not only with the concerns of gears and gearing in mind, but the bearings and seals as well. Bearings and seals are important factors in the reliability of enclosed gearboxes.

Synthetic lubricants are important when the application and/or gearbox design requires the advantages of synthetic lubricants to achieve the desirable equipment reliability. Synthetic lubricants have a comprehensive range of scientifically engineered molecules that offer performance beyond the capabilities of conventional mineral oils.

The understanding of the application and design of the gearbox will enable the user of industrial gears to select the proper lubricant to achieve the maximum productivity. 

continued

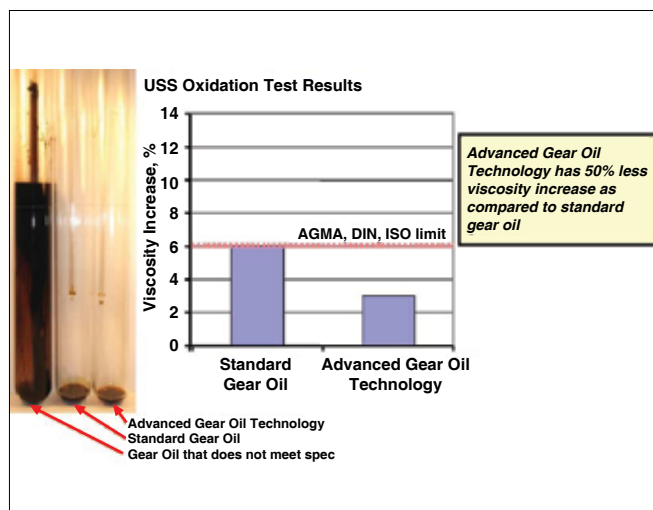


Figure 12—Oxidation test results.



Figure 13—Emcor rust test with 0.5% NaCl water.

Table 3—Features and Benefits of Synthetic Gear Lubricants versus Mineral Oils.	
Thermal and oxidation stability	Longer drain intervals
Low volatility	Lower oil consumption
High viscosity index	Better wear protection
High temperature performance	Better equipment protection
Low temperature performance	Less wear under cold starting conditions
Low traction properties	Reduced energy consumption

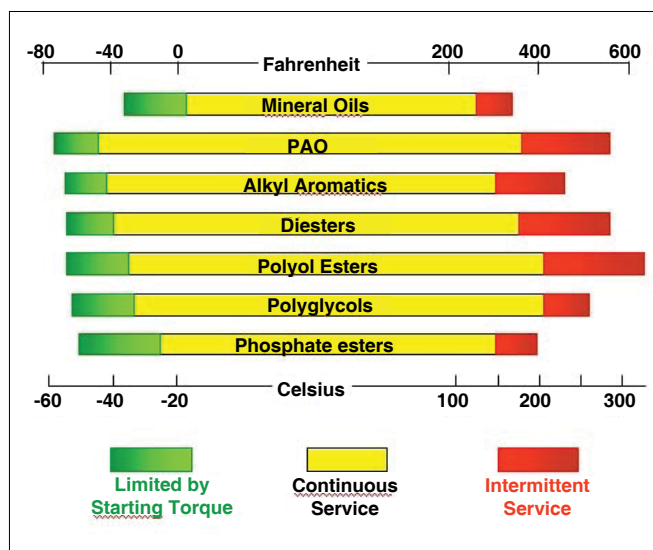


Figure 14—Operating temperature ranges.

## References

1. Shigley, Joseph Edward. *Mechanical Engineering Design*, 3rd Edition, McGraw-Hill, 1977.
2. Gross, William A., L.A. Matsch, V. Castelli, A. Eshel, J.H. Vohr, and M.V. Wildmann, *Fluid Film Lubrication*, John Wiley & Sons, 1980.
3. O'Connor, James J., J. Boyd and E.A. Avallone, *Standard Handbook of Lubrication Engineering*, McGraw-Hill, 1968.
4. Wills, George. *Lubrication Fundamentals*, 1st edition, Marcell-Decker, Inc., 1980.
5. Pirro, D.M. and A.A. Wessol. *Lubrication Fundamentals*, 2nd edition, Marcell-Dekker, Inc., 2001.
6. *Gears and their Lubrication*, 1st edition, Mobil Oil Corporation Products Department, 1971.
7. Errichello, R.. *Lubrication of Gears*, Geartech.
8. Nadasdi, T. "ExxonMobil Strikes the Balance," Publication #XT-0001SH, ExxonMobil.
9. Nadasdi, T. *Introducing Mobilgear 600 XP*, Presentation, 11/03/2006, ExxonMobil.
10. ExxonMobil, <http://www.mobilindustrial.com/Lubes/IND/mobilSHC/benefits.html>.
11. McKenna, K. *Fundamentals of Lubrication*, University of Oklahoma Continuing Education, ExxonMobil, 2005.
12. Webster, M. NREL Micropitting Presentation, ExxonMobil, 2009.
13. Murphy, W.R., D.A. Blain, A.S. Galiano-Roth and P.A. Galvin. "Benefits of Synthetic Lubricants in Industrial Applications," ExxonMobil, 2000.
14. Murphy, W.R., V. M. Cheng, A. Jackson and M. Rochette. "The Effect of Lubricant Traction on Wormgear Efficiency," AGMA Semi-Annual Technical Meeting, 1981.

15. Deckman, D.E., J.R. Lohuis and W.R. Murphy. "Modern Base Stock Technology," *Lubricant World*, July/September, 1997.
16. Skeldar, G. "Trends in Utilization of PAO's," AICHE Spring National Meeting, February, 1996.
17. "Some Straight Talk About 31 Common Lubrication Myths," Mobil Oil, Reprinted from Plant Engineering, WA79ITP888.
18. "Gears," Mobil Oil Corporation, 1980.
19. Nadasdi, T. "IMC Synthetic Lubricants Short Course," ExxonMobil, December, 2005.
20. Deckman, D.E., J.R. Lohuis and W.R. Murphy. "The Impact of Base Stock on Lubricant Performance," ExxonMobil, July 1997.

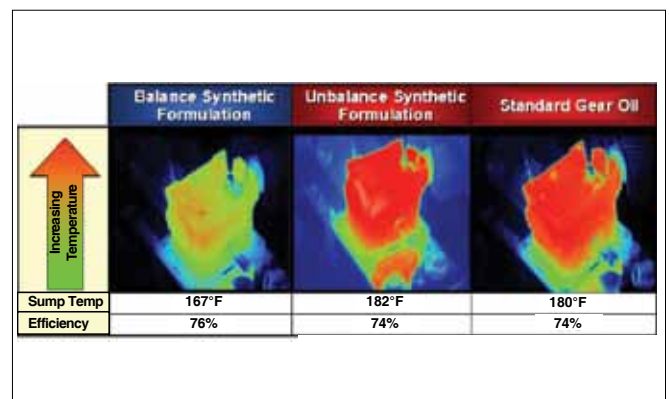


Figure 15—Thermographic images of gearboxes.

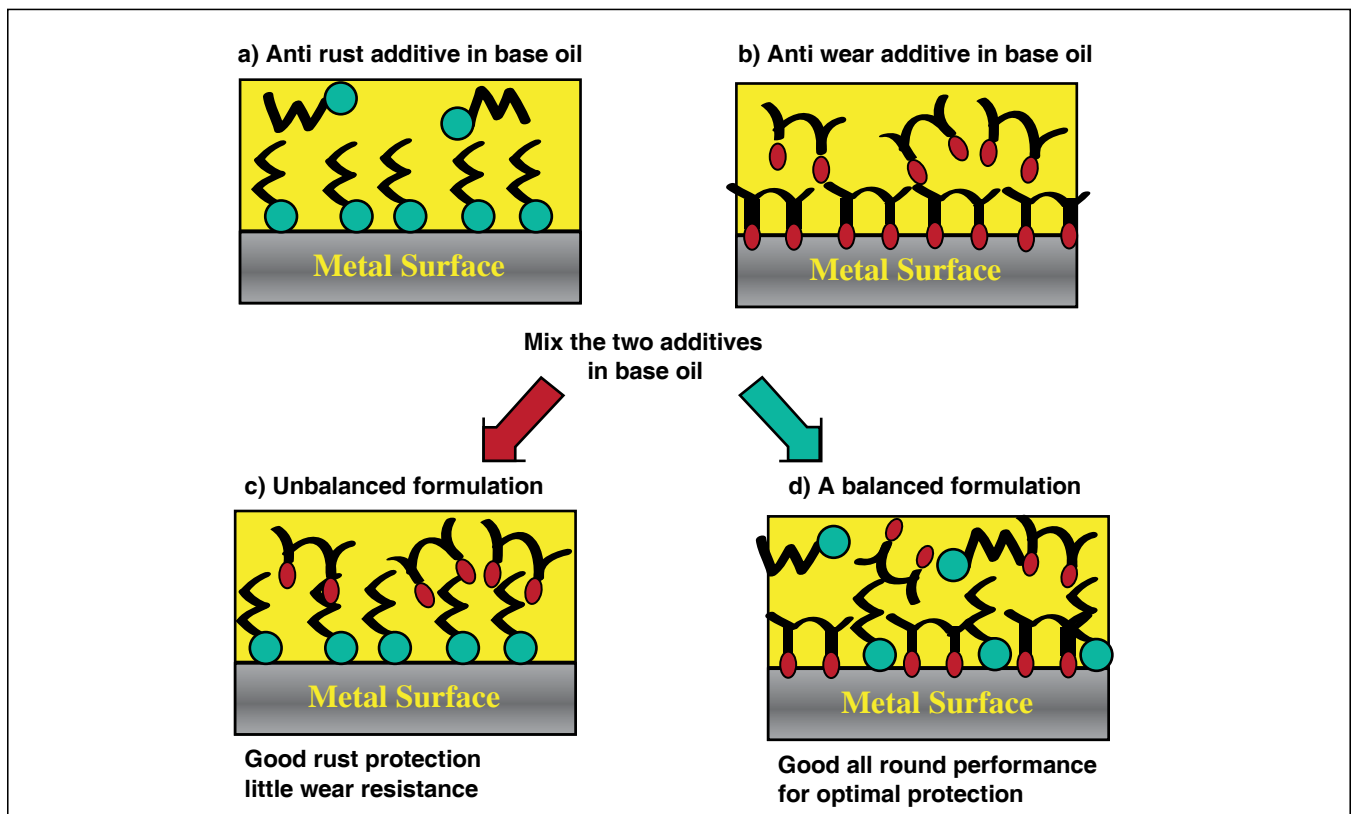


Figure 16—Additives at work.

# Facts versus Myths

**Myth**—If I have micropitting on my gear teeth, a lubricant with a higher level of sulfur-phosphorous package will reduce this failure mode.

**Fact**—Sulfur-phosphorous additive packages have been known to increase the sub-surface fatigue—which leads to micropitting—by aggravating the cracks at the stress point.

**Myth**—If I have wear on my gear teeth, a higher level of anti-wear or anti-scuffing additive will solve the problem.

**Fact**—You need the proper amount of anti-wear and/or anti-scuffing additive in the lubricant to achieve optimum wear protection. If the gear oil has been over-treated with one type of additive to improve one performance dimension, measured by results in a single laboratory test, it is likely that the gear oil will have reduced performance in another key property of the lubricant that may cause another concern. For example, increasing extreme-pressure additive levels can also decrease the oxidative stability of the lubricant.

**Myth**—Proper viscosity of lubricant is important and so a lubricant with a higher viscosity index (VI) is better. (Author's note: Viscosity index is defined as the change in lubricant viscosity with the change in lubricant temperature. As the temperature increases, the viscosity will decrease, and as the temperature decreases, the viscosity will decrease.)

**Fact**—If you take into account the viscosity of the lubricant at the gearbox operating temperature, the first part of this statement is true. However, higher VI is not necessarily better; it depends on how the higher VI is achieved. If it is achieved through use of viscosity index improvers, then a higher viscosity index is not a true benefit in an industrial gearbox. Viscosity index improvers are typically large molecules that will shear down in a relatively short time under the high-shear conditions in industrial gearboxes. After shearing of the VI improvers, the lubricant will provide lower film thickness, leading to increased stresses in the contact areas. These increased stresses will lead to increased wear rates and reduced efficiencies in the gearbox. Another concern is that a very high viscosity index may result in a too-high viscosity for the gears and/or bearings that may cause other type of failures. Always check for proper viscosity for the operating temperatures for the application.

**Myth**—Viscosity determines the lubricity, or “oiliness,” of oil.

**Fact**—Heavier oils (higher viscosity) do form thicker lubricating films, but that's not the whole story. In current gear lubricants, the inherent properties of the base fluids and additives also provide lubricity. Synthetic base fluids can provide lower traction under sliding conditions, and additives, such as fatty materials or friction modifiers, can increase lubricity without necessarily increasing viscosity.

**Myth**—Used oil condition is the primary cause of lubricant-related equipment breakdowns.

**Fact**—The two most prevalent causes of lubricant-related equipment breakdowns are: 1) use of the wrong lubricant, and 2) high concentrations of contaminants in the lubricant.

**Myth**—When it comes to lubrication, nothing is new.

**Fact**—Industrial machines have been getting more powerful, smaller and more complicated, and industrial lubrication has had to keep in step with technology. For example, synthetic lubricants have been developed to meet the demands of high load- carrying capacity for high-output equipment, while also delivering improved energy efficiency versus conventional gear lubricants. Today's lubricants offer improved performance, lower total cost of ownership and improved productivity.



Lumenhaus is Virginia Tech University's 800-square-foot, energy-optimized "smart" home that has the ability to maintain optimal energy performance at all times. It leverages an active system of motion controls from Thomson and Kollmorgen (courtesy M. Cincala).

# The Limbs of Lumenhaus:

## Motion Systems Bring Virginia Tech's Award-Winning and Energy-Optimizing "Smart House" to Life

**L**ast year's winner of the U.S. Department of Energy's (DOE) Solar Decathlon—Virginia Polytechnic Institute and State University—also took first place in the 2010 Solar Decathlon Europe with an 800-square-foot, energy-optimized "smart" home that leverages an active system of motion controls from Thomson and Kollmorgen to minimize the overall HVAC load on the house.

Working with Thomson and Kollmorgen, the Lumenhaus engineering team was able to implement the technology that met their exact performance needs without having to compromise on any of their design objectives to accommodate available motion technology.

"We needed components that could

handle often-harsh and changing environmental elements, readily accept a third-party control signal and that were flexible and easy to interface," says Robert Dunay, director, Center for Research, Virginia Tech.

"We've been pushing the motion control system very hard, and the Thomson and Kollmorgen motion control solutions have absolutely come through for us," Dunay adds.

The thought behind the Lumenhaus design was to build a sustainable smart house with the ability to maintain optimal energy performance at all times.

"When the weather is good, the house automatically opens up and doesn't use energy. Conversely, when the weather turns bad, a system is in place that enables the house to protect

itself," says professor Joseph Wheeler, project coordinator, Virginia Tech.

Lumenhaus epitomizes a "whole-building-design" construction approach, in which all of the home's components and systems have been designed and built to work together to maximize user comfort with environmental protection. At its heart is an integrated environmental control system.

"The house has its own weather station with a 'passive/active' environmental control system to minimize energy consumption and maximize efficiency," explains Wheeler. "In short, the weather station communicates with the control system, which in turn tells the Thomson and Kollmorgen motion system whether to open or close the house. When the house needs insulation, insu-



lation screens close; when the house needs shading, shading screens close; and when the house needs security, the shade screens close without blocking natural ventilation.”

**Making it work.** Lumenhaus’s layered systems consist of a series of motorized shade screens and insulation panels that adjust to the changing weather patterns. The screens and panels can weigh up to 1,000 lbs. each, and coupled with potentially highly dynamic loads from exposure to changing environmental elements, the tools that move them need to be extremely robust.

The shade screen assemblies ride on Thomson 60 Case low-profile round-rail assemblies with Super Smart Ball Bushing bearings, and are run by Thomson RapidTrak belt-driven linear motion systems powered by Kollmorgen AKM servomotors. The insulation panels and shade screens serve as the “clam-shell” that protect the house against the elements. The house also uses Thomson PPA PowerPac actuators as part of a photovoltaic array that tracks and generates power from the sun, and that automatically adjusts to accommodate for changes to the angle of the sun on a seasonal basis.

“Variable feedback provides a certain level of speed and power control, and in dabbling with the overall energy control we’ve been able to move the panels at up to 300 inches per minute, if needed, using just 1.5 amps of power,” says David Clark, student team leader, Virginia Tech. “Using such a small amount of energy to operate these panels can have a big impact, as it means we don’t have to turn on HVAC systems.

“Of course power needs vary depending on weather conditions and the changing dynamic loads from high winds and changes in wind direction, so sometimes we need to tweak the power to optimize performance; the bottom line is that we’re able to do so in such a way as to control consumption and maximize efficiency.”

Lumenhaus constantly monitors weather patterns and automatically adjusts the shade screens and insulation panels as needed, so Virginia Tech engineering students used a 1–10 Micron NemaTRUE planetary gearhead from Thomson inserted between



**All of Lumenhaus’s components and systems are designed and built to work together to maximize user comfort with environmental protection. At its heart is an integrated, environmental control system (courtesy M. Cincala).**

the Kollmorgen AKM servomotor and track drive to increase torque potential, and to help slow down the motor so panels don’t move too fast.

“Generally speaking, we don’t need 10,000 different stops; we just need to reliably get to the right position,” says Clark.

**Manual override? Yes, there’s an app for that.** As with all things automated, there are times that demand a manual override. Lumenhaus utilizes an iPhone and iPad as the interface element, along with Kollmorgen S200 servo drives with digital and analog inputs to help manually override the building control system.

“The building control system takes the information it receives from the iPhone or iPad, interprets it from 1–10, then sends a low-voltage signal out to each servo drive (0–10 v). When the drive receives the information, it interprets it into an exact position count and then sends the screens and insulation panels to the correct position,” explains Clark.

The iPhone and iPad automatically orient the floor plan of Lumenhaus, and with the swipe of a finger on the iPhone or iPad, not only can users override the control system to reorient the screens and panels, but they can also be used to remotely control any number of aspects of the house, including locking or unlocking doors. For example, the front door of Lumenhaus features an

RFID tag that enables remote control to open or lock remotely with the touch of a button. So if one needs to give a neighbor access to the house to let the dogs out, they can do so from any remote location with cellular phone service.

**Potential application, today.** “What’s really interesting about some of the concepts brought to life in Lumenhaus is that it gives us a picture of how, on a smaller scale, existing residential and commercial buildings could be made more energy efficient by retrofitting them with smarter louver-type systems that not only shade but also insulate,” says Dunay. “For example, the ability to have a control system that automatically responds to and even harnesses what the weather gives through means such as blinds, shades and shutters that know where the sun is and can adjust accordingly, is potentially pretty significant when it comes to minimizing HVAC use and power consumption.”

**For more information:**

Thomson  
1500 Mittel Boulevard  
Wood Dale, IL 60191-1073  
Phone: (540) 633-3549  
Fax: (540) 633-0294  
Contactus@kollmorgen.com  
Thomson@thomsonlinear.com  
www.thomsonlinear.com.

# IMTS 2010: IN 140 CHARACTERS OR LESS



Those skeptical that social media can't serve as a valuable networking tool in the manufacturing community take note—Twitter, Facebook, LinkedIn, Flickr and YouTube were just as busy as the exhibition halls during IMTS 2010 in Chicago. Whether it was Bosch Rexroth discussing its energy-efficient machines or Makino pitching a lunch-and-learn series on micromachining, information via tweets, videos and news feeds rolled in all week long.

Even the men and women behind the scenes at IMTS made a strong push to increase the role of social media in 2010.

"We introduced social media at IMTS 2008, but it was very small-scale," says Monica Haley, marketing communications manager at the Association for Manufacturing Technology (AMT). "In the two years since, it has grown and developed with the online preferences of the users."

Haley says exhibitors and attendees used the IMTS blog, Facebook, LinkedIn, Flickr and Twitter to varying degrees to push education about the show and the city. "We used to just post information about the show, the manufacturing and technology and general interest items, but this time we solicited entries from conference speakers and frequent industry tweeters. We posted images from the show floor to the blog and embedded videos which were cross-posted on YouTube."

Many exhibitors took it upon themselves to frequently update Twitter pages with information regarding their booths. This way, attendees knew when to stop by for a product demonstration or when a speaker was scheduled to discuss new technology. With a trade show of this size, the ability to update and share information beyond the official IMTS directory of exhibits proved a valuable commodity.

"Twitter was the most used medium at the show, but it was also the most promoted," Haley adds. "Facebook and YouTube were also popular sites utilized throughout the show. We posted many videos of YouTube, as did several exhibitors. I expect to see at least a handful of visitor 'experience' videos posted in the coming weeks."

IMTS tweeters were encouraged to add the hashtag #IMTS to their tweets during the show so that aggregate sites could draw like entries together to provide a single feed of content. "Televisions throughout IMTS displayed this aggregate, which encouraged others to contribute, and we used *tweetchat.com* to draw the

#IMTS feed," Haley says.

The social media push for the 2010 show began long before the doors opened. "We proliferated prior to the show with more blog entries, chatter on LinkedIn and posting videos to YouTube," Haley says.

Those that couldn't physically attend IMTS 2010 also found advantages to the various social media networks by participating in Twitter discussions, blog posts and YouTube videos online. "It was a useful tool for those who couldn't attend but wanted to experience the show remotely," Haley says.

The trick for keeping social media relevant in the future is to stay current on the various trends. MySpace, for example, played a large role at IMTS 2008 but has faded away as Twitter and Facebook have gained more prominence.

"Social media in general will be a growing part of the show, as well as the months between the shows," Haley says. "The challenge for us is to maintain and up the ante in the conversation. If any of the sites become overshadowed by another medium, we will focus on what's new."

While there aren't final totals for the number of tweets made on the exhibition floors, it appears social media will remain a relevant form of communication for IMTS in the future.

IMTS 2012 will be held September 10–15, 2012 in Chicago. Exhibitors can register now to be part of the initial 2012 assignment. For more information, visit [www.imts.com](http://www.imts.com).

# calendar

**October 20–21—Manufacturing Innovations–Aerospace/Defense.** Gaylord Palms, Orlando, FL. This exhibition is exclusively designed for aerospace and defense manufacturers and suppliers, addressing an expanding market with specific needs for innovation, precision, accelerated production and improved quality. The event will be co-located with the Aerospace Measurement, Inspection and Analysis Conference. For more information, visit [www.sme.org/aerospacedefense](http://www.sme.org/aerospacedefense).

**October 31–November 3—Pack Expo.** McCormick Place, Chicago. As a complete packaging and processing show, Pack Expo allows visitors to connect with colleagues and suppliers, evaluate compatibility of new technology with specific product lines, view packaging machinery in action, see the latest advances in packaging equipment, converting machinery, processing technology, containers and materials. New features in 2010 include the Processing Zone, addressing the production line as a complete process; the confectionary pavilion, sponsored by the National Confectioners Association (NCA); the Brand Zone, formerly the Containers and Materials Pavilion, which will showcase containers and materials designed to increase visual impact, enhance convenience, maximize shelf life and add functionality; and the DistriPak Pavilion, sponsored by the NPTA Alliance (formerly the National Trade Paper Association), which is dedicated to packaging and paper distributors. More than 1,600 exhibiting companies are expected. For more information, visit [www.packexpo.com](http://www.packexpo.com).

**November 3–4—Manufacturing Innovations–Medical, Canada.** International Centre, Hall 6, Toronto. Canada boasts a \$6 billion medical device manufacturing industry with a 52 percent concentration in Ontario. Located in Toronto, this event brings qualified buyers together with sellers

of equipment and products and will focus on medical and dental device manufacturing and the technologies that support quality, innovation and speed to market. For more information, visit [www.sme.org/canmedical](http://www.sme.org/canmedical).

**November 15–19—AME Baltimore 2010 International Lean Conference.** Baltimore. Convention Center, Baltimore. The Association for Manufacturing Excellence (AME) has a long track record for finding and convincing some of the best manufacturing practitioners from around the world to share their lean practice experiences. More than 60 leading presenters will be on hand to discuss customer focus, process sustainment, continuous improvement, material flow and other lean practices and strategies. For more information, visit <http://www.ameconference.org>.

**November 30–December 1—Innovative Automotive Transmissions and Drivetrains. Berlin.** The International CTI Symposium and its specialist exhibition, Transmission Expo, is a European event for people seeking information on the latest technical developments in automotive transmissions and drivetrains. For more information, visit [www.getriebe-symposium.de](http://www.getriebe-symposium.de).

**February 1–2—Offshore Wind Power 2011.** Boston. Following the success of this year's Offshore Wind Power USA event in Philadelphia, Green Power Conferences would like to announce the 2nd annual event taking place in February 2011. Offshore wind energy is the new growth industry in North America, with wind resources off the U.S. coasts offering a vast, yet largely untapped energy potential. Offshore development promises to be a significant domestic renewable energy source, especially for coastal energy loads with limited access to interstate grid transmission. For more information, visit [www2.greenpowerconferences.co.uk](http://www2.greenpowerconferences.co.uk).

**March 1–3—Expo Manufactura.** Cintermex, Monterrey, Mexico. The largest event in Mexico for the processing and manufacturing industries boasts more than 350 companies representing more than 600 national and international brands. Expo Manufactura brings professionals together with technological solutions in aerospace, medical devices, automotive, metallurgical, aeronautics and electrical appliances. More than 9,000 industry professionals will visit the show looking for industry insights, new technologies and networking opportunities. For more information, visit [www.expomanufactura.com.mx](http://www.expomanufactura.com.mx).

**March 21–24 2011—Automate 2011.** McCormick Place, Chicago. Automation technologies such as robotics, machine vision and motion control help companies in every industry become stronger global competitors. Automate 2011 brings together a broad range of integrated solutions while examining the latest technology advances in these fields. Formerly the International Robots, Vision and Motion Control Show held once every two years, Automate 2011 has partnered up with ProMat 2011, a leading trade show for the material handling and logistics industries, to bring guests new ideas that can be put to use immediately. One badge gets you into both shows. For more information, visit [www.automate2011.com](http://www.automate2011.com).

## Garland

BEGINS TESTING  
FLEET'S FIRST HYDRAULIC HYBRID VEHICLE



The City of Garland, Texas, Environmental Water Services Department, recently began a long-term field test evaluation of the Bosch Rexroth Hydrostatic Regenerative Braking (HRB) system to assess the technical, environmental and economic benefits of the parallel hydraulic hybrid system. Sponsored by the Houston Advanced Research Center (HARC) through a grant from the Texas Environmental Research Consortium and with funding provided by the Texas Commission on Environmental Quality, this evaluation program presents a potential solution for significantly reducing exhaust emissions such as nitrogen oxides (NO<sub>x</sub>) and particulate matter (PM), fuel consumption and vehicle operating costs in stop-and-go fleets. The goal is to evaluate the HRB technology as an alternative drivetrain system for the department, potentially leading to wider adoption in refuse trucks in Garland, the State of Texas, and nationwide.

The vehicle is a Crane Carrier LET2 with a Heil Environmental CP Python Rapid Rail automated side loader body. Two identical trucks will be outfitted with data collection systems so that comparison data can be obtained and evaluated. The trucks will be subjected to a variety of in-use testing, including braking tests, acceleration tests, route collection tests and dynamometer testing to evaluate emissions.

The HRB system captures a portion of the kinetic energy normally lost as friction heat during braking, storing it in the form of highly compressed gas for later use in assisting the engine in propelling the vehicle, reducing fuel consumption, wear on the brake system and wear on the engine.

“HARC is pleased to sponsor this type of demonstration project. When proven successful, the technology will help the state of Texas improve air quality for the long-term benefit of our residents. We would like to see this important technology validated in the field so that it can be commercially available soon to reduce emissions and save fuel. I believe that, like the electric hybrid passenger car, hybrid technologies, such as HRB, are the right solutions for this type of heavy-duty application,” says Dr. Yiqun Huang, HARC NTRD program director.

“We are excited to partner with the City of Garland as they enter into field trials,” says Ken Hank, executive vice president, hydraulics, Bosch Rexroth. “With the HRB technology, we feel we can contribute to the achievement of the city’s emissions and fuel savings goals.”

Adds Tyra Lewis, Garland’s project representative, “Fuel savings is a key component of our Environmental Management System (EMS) Program here in Environmental Waste Services. We saw this as an opportunity to explore new options to reduce fuel consumption while testing new technology.”

## Parker

TEAMS WITH CAL MOTORS  
ON HYBRID-ELECTRIC TRUCK DESIGN



Parker's Electromechanical Automation Division, a supplier of motion control technology, recently announced that its MPP series traction motor and inverter are integral components of a series-electric hybrid truck deployed by US 1 Industries to serve at the Port of Long Beach. The US 1 truck uses a 215 kW Parker MPP traction motor as the single source of torque for its Class 8 truck—a large tractor-trailer truck with a gross vehicle weight of 80,000 lbs. Thanks to the large speed range of the MPP, the truck can travel at a continuous velocity of 70 mph. Using the MPP motor, the truck has better acceleration and passing capabilities compared to the stock diesel engine typically in the truck. An onboard generator will be used to recharge the batteries as energy is depleted, giving it a range of 200 miles on a single charge at full load.

CalMotors is the company responsible for the complete integration of the powertrain. "Their intimate knowledge of the Parker components is invaluable to the optimization and ultimate success of this vehicle," says Jay Schultz, product manager for Parker's MPP motors.

The first truck will serve as a test vehicle and will collect data over a few months to confirm the theoretical performance calculations predicted by CalMotors. The Parker drive system is expected to have a timely payback for US 1; however, the emissions reduction will be realized immediately. "Parker has been an excellent partner for CalMotors as we engineer complete powertrain solutions for all sizes of vehicles," says Mike Kasaba, president of CalMotors. "The motor efficiency, performance and broad range of motor options along with Parker's agility and fast response time have allowed us to tailor an impressive powertrain system for a Class 8 truck."

Designed for the demanding applications found in today's high-performance electric and hybrid vehicles, Parker's MPP traction motors offer lower weight and higher power, all in a smaller package than other traction motors. High-performance neodymium magnets are employed for higher torque output. Parker's MPP motors feature innovative winding design and Parker's exclusive dual cooling implementation, which features a patent-pending internal cooling technology. This design yields up to 40 percent higher torque per unit size than conventionally constructed permanent magnet motors. The Port of Los Angeles and the Port of Long Beach have strict Clean Truck Programs, which mandate that all trucks that do not meet the 2007 Federal Clean Truck Emissions Standards be banned from the facility, which stretches along 43 miles of waterfront. By implementing Parker's MPP motors and inverters in their trucks, Cal Motors and US 1 are helping the busiest container port in the country meet its emission goals.

Quality Products That Meet Customer Specifications Delivered on Time...

CNC Gear Grinding

CNC Gear Analysis

CNC OD/ID Grinding

**gmi** GEAR MANUFACTURING INCORPORATED

Anaheim, CA 92806 Ph (800)773-GEAR  
[info@gearmfg.com](mailto:info@gearmfg.com)  
[www.gearmanufacturing.com](http://www.gearmanufacturing.com)

Complete Precision Gears & Assy's Under One Roof...

ISO 9001:2000 and AS9100 Registered

PRECISION GAGE COMPANY  
*"Quality Since 1948"*

+ GearMaster - Backed by 50 years Experience

Large Gear Inspection (up to 15" center distance)

Nick and Burr Detection

Spur, Helical, Worm and Bevel Gears

For greater accuracy and efficiency, as well as historical record tracking, use GearMaster with the Vari-PC Gear Analyzer to achieve all your composite gear inspection and analysis needs.



100 Shore Drive  
 Burr Ridge, IL 60527  
 Phone: 630-655-2121  
 Fax: 630-655-3073  
[www.precisiongageco.com](http://www.precisiongageco.com)



ISO 9001 CERTIFIED

## Emerson

RECEIVES INTERNATIONAL TRADE AWARD



**Kentucky Congressman Geoff Davis (left) presents Power Transmission Solutions' Brad Gossard with international trade award.**

Emerson Industrial Automation, Power Transmission Solutions business unit, was recently awarded the 2010 Northern Kentucky International Trade Award of Excellence. The award recognizes regional companies who have distinguished themselves through successfully engaging in international trade. Companies are judged on revenue generation, global network, risk mitigation and organizational structure. The award was presented by Kentucky Congressman Geoff Davis. According to Tony Pajk, Power Transmission Solutions president, "This award recognizes the ability of our people to successfully execute our global growth strategy in a highly competitive world. As a solutions provider, we clearly understand that making our global customers successful through our international presence offers significant benefits for our employees, our supplier partners and all the communities in which we operate."

Power Transmission Solutions currently has two plants in Canada, two in Mexico, two in Brazil, seven in the United States, five in Europe and three in Asia.

The company is also partnering with current customers to expand its presence in international markets. Examples include: gas turbines for energy applications, hydrofoil and fast ferry applications, wind industry components and a high-speed conveyor chain that helps bottling and food packaging companies meet their global water conservation targets. Conservation of fresh water is key to emerging markets. Brad Gossard, global vice president of marketing, notes, "We integrate the services of our international locations into the daily operation of our U.S. facilities. This has shortened our reaction time for dynamic market changes and opportunities."

## Moventas

EXPANDS GLOBAL MANUFACTURING REACH

With an investment in Portland, Oregon, Moventas is taking a significant step to expand its global manufacturing and assembly offerings for both wind turbine manufacturers and gear service customers. "The United States is one of the fastest growing wind markets and a natural choice for expanding our existing Moventas facility in Portland," says Jukka Jäämaa, Moventas CEO and president. "The initial capacity will be 200 MW, which means 100–150 mid-size wind turbine gears per year. We will also continue with the preparations for building up even larger capacity in the Midwest."

Currently, Moventas has concentrated wind gear manufacturing in Jyväskylä, Finland. The ultramodern facilities in Jyväskylä will continue to manufacture key wind gear components in the future, but the assembly and testing capacity for United States deliveries will be moved closer to customers. In North America, Moventas already has gear service facilities in South Carolina, Texas, Oregon and Ontario, Canada.

## Kan

NAMED WOMAN ENTREPRENEUR OF THE YEAR

Bishop-Wisecarver Corporation, manufacturer of guided motion technology, recently announced that company president Pamela Kan has been named Woman Entrepreneur of the Year in Pittsburg, California. "I am really honored to be acknowledged for this award," says Kan. "I hope in some small way this recognition will inspire younger women to get involved in manufacturing. This great industry fuels the economic engine of our country, and there is the potential for women to make an impact on this sector."



**Pamela Kan**

The award is given by Bay Area nonprofit Women's Initiative for Self-Employment, recognizing women entrepreneurs in the Bay Area who have been successful despite the barriers that exist for women business owners, who exemplify how business ownership and leadership is beneficial for women, who have a positive impact on the local community or the community at large, and who advance their business through innovation.

In recognizing these businesses, Women's Initiative celebrates the power of small businesses in transforming communities through job creation and economic revitalization. In fact, recent research from Women's Initiative shows that their graduates created more than 2,200 jobs in 2009 alone. The Woman Entrepreneur of the Year Award recognizes these women entrepreneurs and their businesses for their leadership and positive contributions to their communities. Kan was recognized at the Woman Entrepreneur of the Year Awards Ceremony on October 5, 2010 at the Round Hill Country Club in Alamo, California.

## NFPA

### CHALLENGES EIGHTH-GRADERS ON HYDRAULICS AND PNEUMATICS

The National Fluid Power Association (NFPA) Fluid Power Challenge is a competition that challenges eighth grade students to solve an engineering problem using hydraulics and pneumatics. The students work in teams of four, two boys and two girls, to design and build a fluid power mechanism, and then compete against other teams in a timed competition. Any middle school, university or fluid power company can now run a challenge event on their own. The instructions include a budget, timetable and sample e-mails, along with forms that local organizers can use and customize for their individual events. The online instructions contain detailed information for challenge coordinators, facilitators and judges, including ordering information for challenge kits, T-shirts and trophies, as well as judging criteria and step-by-step procedures for the Workshop day. Teachers can also hold a Fluid Power Challenge in their classrooms by using classroom exercise kits—a pneumatic lifter, rotational arm and clamp—which demonstrate linear and rotational movements. These kits give teachers the tools they need to teach fluid power in the classroom and experiment with hydraulics and pneumatics before entering teams in a challenge event. The NFPA Fluid Power Challenge exposes middle school students to a learning environment where engineering and math are fun, and encourages them to develop their teamwork and problem solving skills. They are introduced to careers in the fluid power industry, and teachers receive support and resources for science and technology curriculum. The complete instructions for the project can be found at [http://www.nfpa.com/Education/Challenge\\_Instructions.asp](http://www.nfpa.com/Education/Challenge_Instructions.asp).

**METRIC WORMS & WORMGEARS**

Exclusive North American Distributor of **KHK GEAR**  
www.khkgears.co.jp

With our selection of standardized metric worm gear sets, QTC will meet all of your worm gear requirements.

Available from stock are modules 0.5 thru 6 in ratios of 100:1 to 20:1.

Materials such as Alloy Steel, Stainless Steel, Carbon Steel, Aluminum Bronze, Bronze, Cast Iron & Nylon.

**QTC** Quality Transmission Components  
Phone: 516.437.6700  
Fax: 516.328.3343  
www.qtcgears.com

GLOBAL SPEC

WORMS & WORMGEARS • WORMS & WORMGEARS

**Find Suppliers of  
Gears, Bearings,  
Motors,  
Gear Drives  
...and more at  
powertransmission.com**

Power Transmission Engineering Magazine Archives of Power Transmission Components / Gear, Be, Wormed, Planetary, Gear

Home | Gear | Be | Wormed | Planetary | Gear

GEARS BEARINGS MOTORS GEAR DRIVES CHAIN DRIVES BELT DRIVES SOLUTIONS BRAKES  
HYDRAULIC POWER LINEAR MOTION SENSORS COLPILDS Home

Power Transmission Engineering Magazine

**PTC** Eagle NRG up to 25% more power capacity

Development of an Educational Engineering Workshop on Electric Vehicle and Motor Technology

June 2010 Power Transmission Engineering

Table of Contents

Use other back issues

Subscribe to Power Transmission Engineering (PTCE)

## **Andantex**

Page 4  
Phone: (732) 493-2812  
Fax: (732) 493-2949  
[info@andantex.com](mailto:info@andantex.com)  
[www.andantex.com](http://www.andantex.com)

## **Automation Direct**

Inside Front Cover  
Phone: (800) 633-0405  
[www.automationdirect.com](http://www.automationdirect.com)

## **B&R Machine and Gear**

Inside Back Cover  
Phone: (731) 456-2636 or  
(800) 238-0651  
Fax: (731) 456-3073  
[inquiry@brgear.com](mailto:inquiry@brgear.com)  
[www.brgear.com](http://www.brgear.com)

## **Binsfeld Engineering Inc.**

Page 15  
Phone: (231) 334-4383  
[sales@binsfeld.com](mailto:sales@binsfeld.com)  
[www.binsfeld.com](http://www.binsfeld.com)

## **Circle Gear Co.**

Page 47  
Phone: (708) 652-1000  
Fax: (708) 652-1100  
[sales@circlegear.com](mailto:sales@circlegear.com)  
[www.circlegear.com](http://www.circlegear.com)

## **Clifford-Jacobs Forging Co.**

Page 15  
Phone: (217) 352-5172  
[sales@clifford-jacobs.com](mailto:sales@clifford-jacobs.com)  
[www.clifford-jacobs.com](http://www.clifford-jacobs.com)

## **Delta Gear**

Page 5  
Phone: (734) 525-8000  
Fax: (734) 525-8400  
[sales@delta-gear.com](mailto:sales@delta-gear.com)  
[www.delta-gear.com](http://www.delta-gear.com)

## **Excel Gear**

Page 47  
Phone: (815) 623-3414  
Fax: (815) 623-3314  
[Chinn@ExcelGear.com](mailto:Chinn@ExcelGear.com)  
[www.excelgear.com](http://www.excelgear.com)

## **Forest City Gear**

Page 3  
Phone: (815) 623-2168  
Fax: (815) 623-6620  
[fyoung@fcgear.com](mailto:fyoung@fcgear.com)  
[www.fcgear.com](http://www.fcgear.com)

## **Gear Manufacturing Inc.**

Page 43  
Phone: (800) 773-GEAR  
[www.gearmanufacturing.com](http://www.gearmanufacturing.com)

## **Gear Motions Inc.**

Page 47  
Phone: (315) 488-0100  
[ron.wright@gearmotions.com](mailto:ron.wright@gearmotions.com)  
[www.gearmotions.com](http://www.gearmotions.com)

## **The Gear Works—Seattle, Inc.**

Page 47  
Phone: (206) 762-3333  
[sales@thegearworks.com](mailto:sales@thegearworks.com)  
[www.thegearworks.com](http://www.thegearworks.com)

## **Martin Sprocket & Gear**

Page 19  
Phone: (817) 258-3000  
[www.martinsprocket.com](http://www.martinsprocket.com)

## **McInnes Rolled Rings**

Page 28  
Phone: (800) 569-1420  
[sales@mcrings.com](mailto:sales@mcrings.com)  
[www.mcinnesrolledrings.com](http://www.mcinnesrolledrings.com)

## **MGT – Magnetic Gearing & Turbine Corp.**

Page 7  
Phone : +(61) 402-383-352  
[sales@mgt.com.au](mailto:sales@mgt.com.au)  
[www.mgt.com.au](http://www.mgt.com.au)

## **Precision Gage Co., Inc.**

Page 43  
Phone: (630) 655-2121  
[sales@precisiongageco.com](mailto:sales@precisiongageco.com)  
[www.precisiongageco.com](http://www.precisiongageco.com)

## **Quality Reducer Service**

Page 47  
Phone: (708) 354-8080  
[www.qualityreducer.com](http://www.qualityreducer.com)

## **Quality Transmission Components**

Page 45  
Phone: (516) 437-6700  
[www.qtcgears.com](http://www.qtcgears.com)

## **R+W**

Page 13  
Phone: (630) 521-9911  
[www.rw-america.com](http://www.rw-america.com)

## **Schafer Gear**

Page 11  
Phone: (574) 234-4116  
[www.schafergear.com](http://www.schafergear.com)

## **Stock Drive Products/Sterling Instrument**

Back Cover  
Phone: (516) 328-3300  
Fax: (516) 326-8827  
[SDP-SIsupport@sdp-si.com](mailto:SDP-SIsupport@sdp-si.com)  
[www.sdp-si.com](http://www.sdp-si.com)

## **Taiwan Precision Gear**

Page 47  
Phone: +(886) 4-25351329  
Fax: +(886) 4-25351467  
[tpgcorp@ms13.hinet.net](mailto:tpgcorp@ms13.hinet.net)  
[www.tpg-tw.com](http://www.tpg-tw.com)



Gear Manufacturing

## QUALITY CUSTOM GEARING!

**Documented Quality Control Program**

**Inspection Lab including Complete Gear Tooth Diagnostics**

**Tooth Cutting, Grinding & Shaving Services Available**

All Sizes & Configurations

- Reverse Engineering
- Design Analysis
- Complete Machine Shop Including CNC Machining



**Circle Gear and Machine**  
Quality Custom Gearing Since 1951

1501 South 55th Ct. • Cicero, IL 60804  
Ph: 708-652-1000 • Fax: 708-652-1100

Please email your inquiries to [sales@circlegear.com](mailto:sales@circlegear.com) • [www.circlegear.com](http://www.circlegear.com)

Gear Manufacturing

## TPG GEAR MOTOR

(MOTORS | DRIVES)

- Ratio: 1:5 ~ 1:1200
- Horse Power: 0.1KW-7.5KW
- Voltage: 1Ø, 100-120V, 200-240V, 3Ø, 220/380V, 220/440V, 200/400V, 208/415V



**TAIWAN PRECISION GEAR CORP.**

Tel: 886-4-25351329 Fax: 886-4-25351467  
E-mail: [tpgcorp@ms13.hinet.net](mailto:tpgcorp@ms13.hinet.net)

Visit our website : [www.tpg-tw.com](http://www.tpg-tw.com) for details

Gear Manufacturing



Ingenuity in Motion

Gearbox Repair  
Gear Metrology  
Gear Grinding to 2600 mm  
Industrial Gears  
Custom Gearboxes  
Turbo Compressor Gears  
Machining  
Emergency Service  
ISO 9001 Certified

Seattle, Washington | 206.762.3333  
[www.thegearworks.com](http://www.thegearworks.com)

Gear Manufacturing



## Ground Gear Manufacturing

### GEAR MOTIONS, INC.

An Employee Owned Company

Learn about one of the most modern fleets of Gear Grinders, including the Höfler 700 and Gleason Tag 400 at ISO 9001:2008 registered Oliver Gear. See the latest Reishauer and Kapp Gear Grinding technology, at ISO 9001:2008 registered Nixon Gear, as well as the latest in CNC Gear Hobbing and cellular manufacturing.

PH: (315) 488-0100  
[ron.wright@gearmotions.com](mailto:ron.wright@gearmotions.com)  
[www.gearmotions.com](http://www.gearmotions.com)

Gear Manufacturing

## Excel Gears.. Turbohands! And Much More!

Precision gears, high-speed spindles, CNC gimbal heads, wind turbines, even gearbox assemblies for battleship gun turrets. That's the breadth of design, build and testing capabilities Excel brings to your company for high speed and high power, with smooth and quiet operation. Gear grinding to AGMA 15 (DIN 2) at 60° external diameters, gear hobbing to 70° maximum pitch diameter. All with our personalized service and guaranteed performance.





Excel seeks wind turbine gearbox builders looking to source in USA



**EXCEL GEAR, INC.**  
A TOTAL SERVICE COMPANY

excelgear.com  
815.623.3413

Gearbox Services

## QUALITY REDUCER SERVICE

### GEARBOX REPAIR SPECIALISTS

Since 1989

- Prompt and accurate quotations
- Competitive Pricing
- Quality repair & rebuilds

WE SERVICE ALL TYPES OF INDUSTRIAL GEARBOXES

**Quality Reducer Service**  
620 East Avenue  
LaGrange, IL 60525  
708-354-8080  
[qualityreducer.com](http://qualityreducer.com)



# VIDEOS

Now Online  
See your favorite gears, bearings, motors, clutches, couplings and more in action



Magnetic Couplings & Gearing - MGT HDV.mpg

## powertransmission.com

Submit your videos to  
[wrs@geartechology.com](mailto:wrs@geartechology.com)

## Vive (American) LaFrance!

### Turbine-Powered 1961-Vintage Pumper Truck Was

### “Red-HOT”



A 1961, 900-Series American-LaFrance 1,000-gpm pumper truck. The engine is by Boeing—a \$10,000 option. The truck was one of three that American-LaFrance built that year and the only one shipped to the East Coast—specifically, to Mount Vernon, Virginia, where Dave Collins worked at the time as a professional firefighter. Note how the clearance between the top of the tire and the front fender opening speaks to how light the engine was. (courtesy Dave Collins).

Energy—how to produce it cleanly and how to conserve it—presents a daunting challenge for developed and developing countries around the globe. And it’s a challenge that is only beginning to be met by those countries’ governments. So it may come as somewhat of a surprise to know that decades ago—a decade before Earth Day—attempts at energy conservation were not unheard of. Witness the turbine-powered 1961 American LaFrance pumper (pictured)—at that time a rare part of the fleet at the fire house in Mount Vernon, VA.

To tell us more about it, the Power Play team spoke with Dave Collins, a 25-year veteran of Fairfax County (VA) Fire and Rescue. “Fairfax County Fire and Rescue is a very progressive fire service,” says Collins, “and I am proud to be able to say that I was a part of such an elite department. We are known worldwide as we have sent crews to Russia, Haiti and other areas in times of disaster. We usually have an employment waiting list of 150 + men and women.”

Inspired by a recent profile of Chrysler turbine pioneer George Huebner in the October 2010 issue of *Hemmings Classic Car*, Collins recalls that the LaFrance pumper was one of three that American-LaFrance built that year, and was the only one shipped to the East Coast—specifically, to Mount Vernon. So Collins had the chance to man the wheel of the pumper many times, even once driving it as far as Washington, D.C. to participate in a special display of turbine-powered vehicles. Here’s how Dave tells it.

“It is a 1961 900-Series American LaFrance, 1,000-GPM pumper. The engine was made by Boeing Aircraft—weighing in at approximately 330 lbs.—and gave us approximately 330 blown horsepower. If you note in the picture, the clearance between the top of the tire and the front fender opening speaks to how light the engine was. The chrome stack—it looks a bit like something off a steamship—was the exhaust stack. The engine was rather unique in that it had an air intake at the front axle. There was an intake impeller, two fireboxes and a second impeller. The first and second impellers were directly connected to each other by a single shaft. There was a third impeller— inches from the second one—with no direct connection. The burning fuel in the fireboxes turned numbers 1 and 2 impellers—the thrust coming off #2 would turn #3. That 3rd impeller was connected to a gear reduction box. Connected to the gear reduction box was a normal flywheel

and clutch and five-speed transmission. Since there was no direct connection between the #2 and #3 impellers, you could put the transmission in gear, hold the brake and let the clutch out until you were ready to move, and then let your foot off the brake and roll down the road. The gear reduction box was needed because the engine idled at 19 thousand, with a top-RPM of 39,000! The starter and igniters brought the engine to 10,000 rpm. At that point incoming fuel was ignited by what was already in there burning. Under normal driving, we came out of the building starting in 5th gear, because if you did normal shifting you lost too many RPMs between each shift. Using 5th gear got you to top-speed quicker. Lower gear starts were more for hills.

“On occasion, when starting the engine, you would get a “hot start”— i.e., flame bursting from the exhaust stack. With no one among us harboring a death wish, we had to install asbestos on the ceiling above the pumper. One more thing—the heat from the exhaust would break the window panes in the door in winter, so we changed the center panes to heat-resistant glass.

“The engine fuel was kerosene.

“The ‘apparatus’ was extremely fun to drive. At the time of purchase, the turbine engine was a princely \$10,000 option.

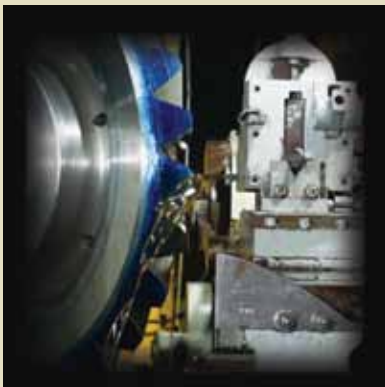
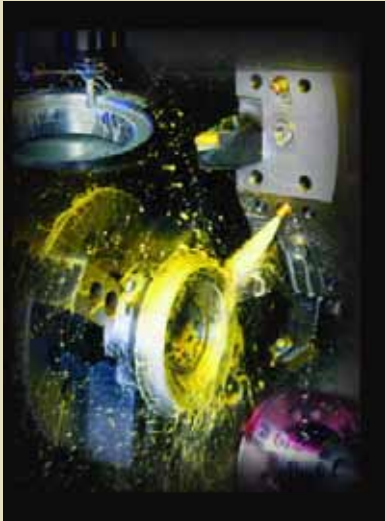
“A big drawback was maintenance—if we had a problem, we had to fly a Boeing mechanic in to do the repairs, feed him and put him up in a motel. One trip, he decided to stay in our bunkroom and, naturally, it turned out to be a busy time and we ran all night. So he didn’t get any sleep.

“The vehicle was kept in service for about 10 years, but not all of that turbine-driven. The fuel-control governor went out—probably in 1966-67. The cost would have been \$3,000 (at that time) to replace it. The fuel-control governor was, for all practical purposes, a carburetor. But— needless to say—more complicated. Engine maintenance was becoming cost-prohibitive—especially with having to fly in the Boeing mechanic each time.

“When the turbine was removed, a Continental inline six-cylinder was its replacement. The turbine was sold to a racer in California. Eventually, the pumper ended up at our academy as a training piece for the recruits. It was eventually sold at auction.”

# CUSTOM

## BEVEL GEAR MANUFACTURING



**INVERSE ENGINEERING**

**BREAKDOWN SERVICES**

**IN-HOUSE STEEL MATERIAL WAREHOUSE**

**STRAIGHT BEVEL GEARS: 80" PD**

**SPIRAL BEVEL GEARS: 66" PD**

**FULL HEAT TREATING SERVICES**

**SPURS, HELICALS, SPLINE SHAFTS**

**GEARBOX REPAIR/REBUILDS**

**EDM WIRE BURNING**

# B&R

**Machine and Gear Corporation**

**Toll Free: (800) 238-0651**

**[inquiry@brgear.com](mailto:inquiry@brgear.com) • [www.brgear.com](http://www.brgear.com)**



# YOUR COMPLETE SOURCE FOR **BEARINGS**

Now Offering 100,000 Inch & Metric  
Precision & Commercial Quality Drive Components

Off-The-Shelf to Customized Applications

Large & Small Quantities Available

Buy Online Or Call For A Quote

Request Your Free Catalog

Download 3D Models

**ISO  
Certified**



[www.sdp-si.com](http://www.sdp-si.com)

P: 800.819.8900 F: 516.326.8827

**SDPSI** Setting Ideas into Motion