

Power Transmission Engineering®

OCTOBER 2018

LUBRICATION

GEARBOX PERFORMANCE IMPROVEMENTS

GEARMOTORS

ADAPTING TO A 4.0 WORLD



Speed and power,
in perfect sync.

INTRODUCING

IPMax

IPM MAXIMUM PERFORMANCE

Brother's Premium Efficiency IPM
(Interior Permanent Magnet) Gearmotors.
Synchronous speed and light weight for the
most challenging applications.

- Synchronous no-slip motor provides superior control
- Wide speed range can reduce need for multiple ratios
- Extreme high efficiency – class ie4 motor PLUS hypoid gearing
- High start and stop capabilities
- More torque in a compact and lighter package
- No fan on most units

Call us today for a sample gearmotor to try out!



brother
at your side

866.523.6283

BrotherGearmotors.com

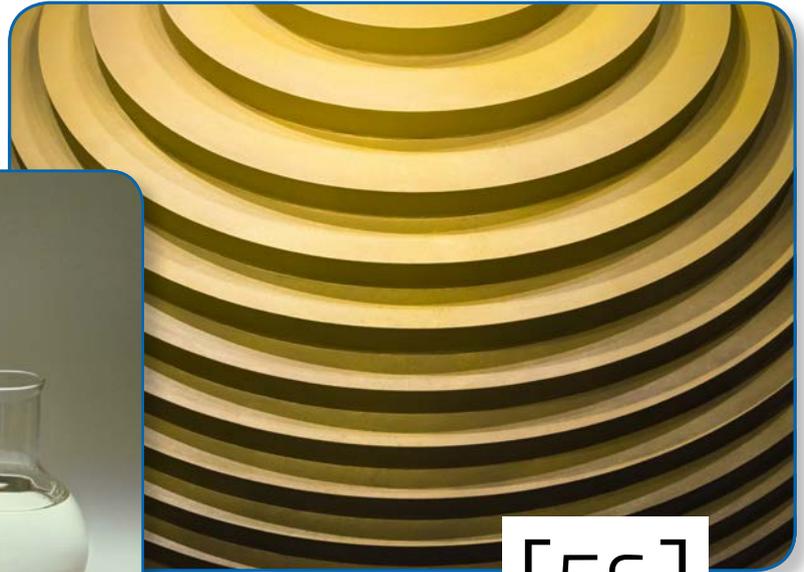
Gearmotorsmarketing@Brother.com

Power Transmission Engineering®

OCTOBER 2018



[18]



[56]

FEATURE ARTICLES

- [18] **The Consistency Game**
A look at gear & gear drive lubrication performance improvements.
- [24] **Gearmotors Pulling, Pushing — and Controlling — Their Weight**
Industrial mainstay adapts to stay relevant in a 4.0 world.
- [30] **Hannover Messe USA**
What we learned.
- [44] **The Future of E-Mobility**
Schaeffler touts system solutions and electrification advances at Detroit symposium.

TECHNICAL ARTICLES

- [32] **Step vs. Servo — Selecting the Best**
This article explains the basics of each system and the differences between open loop and closed loop control systems.
- [38] **Smashing the Efficiency Barrier — A Practical Comparison of Planetary and Orbitless Gear-Heads**
An Orbitless (patent pending) gearhead is a novel fixed-ratio epicyclic gear-head with crank-shaft planet pinions and two carriers, but no ring gear.

Vol. 12, No. 7. POWER TRANSMISSION ENGINEERING (ISSN 2331-2483) is published monthly except in January, May, July and November by Randall Publications LLC, 1840 Jarvis Ave., Elk Grove Village, IL 60007, (847) 437-6604. Cover price \$7.00. U.S. Periodicals Postage Paid at Elk Grove Village IL and at additional mailing offices. Send address changes to POWER TRANSMISSION ENGINEERING, 1840 Jarvis Ave., Elk Grove Village, IL 60007.

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. ©2017 Contents copyrighted by RANDALL PUBLICATIONS, LLC. 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.

Full Service Standard & Custom Gear Production



- **Gear Milling** of external involute gear forms including, but not limited to:
Helical – Double Helical – Spur – Herringbone
- **Reverse Engineering** of Standard & **Metric** tooth forms
- **Up to AGMA 12 Quality Level** (Standard 2000-A88)
- **Tooth Profile Modification** for prototypes or production
- **Custom Metrology**



ZEISS
PRISMO® Navigator
with rotary axis ▼



▲ **DMG**
DMC 160 FD duoBlock®
5 axis vertical mill-turn



Call Today
254.675.8651
For
a
Quote



Capacity

- 2" to 16" OD pinions up to 64" in length
- Up to 56" OD gears and 20" face width
- Metrology: (X)62" (Y)118" (Z)55"

~ **ISO 9001 Quality System Certified** ~

Manufacturing quality products since 1927



GEARENCH™

Clifton, Texas • www.gearench.com

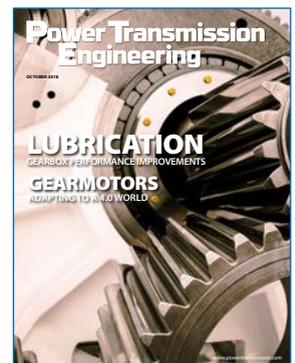
sales@gearench.com • (254)675-8651 • fax (254)675-6100



Power Transmission Engineering

VOL. 12, NO. 7

- [04] **PTEExtras**
Online videos and exclusive articles from www.powertransmission.com.
- [06] **Publisher's Page**
Show me something.
- [08] **Product News**
Gearing Solutions provides yaw drives for wind power; **SKF** presents electromechanical actuators.
- [28] **Engineering sMART**
Products and services marketplace.
- [47] **Calendar**
October 31-November 1: Advanced Engineering 2018, Birmingham, UK;
December 3-6: CTI Symposium, Germany;
December 4-6: Power-Gen International, Orlando.
- [48] **Industry News**
BSA Excellence Awards, plus new hires and other company news.
- [54] **Advertiser Index**
How and where to reach every supplier in this issue.
- [55] **Subscriptions**
Free subscriptions, anywhere in the world.
- [56] **Power Play**
Earthquake-proofing a building.



Cover photo courtesy of
Kluber Lubrication



ABB servo motors

precise control in a
compact design

ABB's AC servo motors were created for industrial, automated applications that require precise control for **positioning, speed** and **acceleration** such as packaging, labeling, wrapping, and cutting. Designed for **durability**, we also offer a wide choice of inertia, winding, and feedback options.

More torque. Less cogging. Superior performance.

479-646-4711
new.abb.com/motors-generators



Editor's Choice: Cooling Tower Components: Pros and Cons

Cooling towers can use several power transmission technologies, including a gear drive, belt drive, direct drive, and electronically commutated (EC) drive. Each has advantages and disadvantages. The proper selection strikes an appropriate balance of initial cost versus operating costs. Learn more at

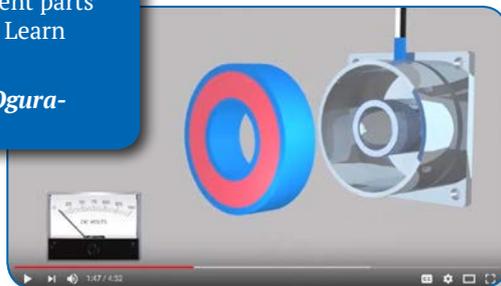
www.powertransmission.com/blog/cooling-tower-components-pros-and-cons/



**PTE Videos
Ogura Permanent Magnet Brakes**

Ogura has created a new animation showing how permanent magnet brakes work. The animation shows an exploded view of the component parts and how they interact with each other. Learn more at:

www.powertransmission.com/videos/Ogura-Permanent-Magnet-Brakes-/



Event Spotlight: Power-Gen International 2018

Power-Gen International provides comprehensive coverage of the trends, technologies and issues facing the generation sector. Displaying a wide variety of products and services, Power-Gen International represents a horizontal look at the industry with key emphasis on new solutions and innovations for the future. Learn more at:

www.powertransmission.com/news/9025/Power-Gen-International-2018/

Check out the latest reports from IMTS 2018 with our PTE-TV Revolutions video series here:

www.powertransmission.com/tv/

Stay Connected



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



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



Subscribe Online
www.powertransmission.com/subscribe.htm

Power Transmission Engineering

Randall Publications LLC

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

EDITORIAL

Publisher & Editor-in-Chief

Michael Goldstein
publisher@powertransmission.com

Managing Editor & Associate Publisher

Randy Stott
wrs@powertransmission.com

Senior Editor

Jack McGuinn
jmcguinn@powertransmission.com

Senior Editor

Matthew Jaster
mjaster@powertransmission.com

Associate Editor

Alex Cannella
alex@geartechnology.com

Editorial Consultant

Paul R. Goldstein

ART

Art Director

David Ropinski
dropinski@powertransmission.com

ADVERTISING

Advertising Sales Manager & Associate Publisher

Dave Friedman
dave@powertransmission.com

eMarketing Specialist

Matthew Stott
matthewstott@powertransmission.com

China Sales Agent

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

Materials Coordinator

Dorothy Fiandaca
dee@randallpublications.com

CIRCULATION

Circulation Manager

Carol Tratar
subscribe@powertransmission.com

Circulation Coordinator

Barbara Novak
bnovak@powertransmission.com

RANDALL PUBLICATIONS STAFF

President

Michael Goldstein

Accounting

Luann Harrold





PRECISE. ROBUST. AVAILABLE

These new generation CD® Couplings feature zero backlash precision and high torsional stiffness. They answer today's demanding needs in servo motor applications with high reverse loads and positioning requirements. New clamp style hubs handle increased torque on shafts without using keyways. Manufactured of RoHS compliant materials.

Now size, select and see the right CD® Coupling solution for your coupling application with Zero-Max 3D CAD files.

Check our FAST deliveries.



www.zero-max.com 800.533.1731

////// ZERO-MAX®

Show Me Something



Fall is the season of change. But in industrial America, it's also the season of trade shows. Either way, the season is in full swing.

We've just come back from a very successful exhibit at IMTS, which included, for the first time, the Hannover Messe USA show. We met with hundreds of suppliers in our industry, including a great many manufacturers of motion control and mechanical power transmission components and systems.

In fact, we were able to sit down with a number of those suppliers to conduct video interviews as part of our new *Revolutions* segment on *Power Transmission Engineering TV*. The segment features technical experts from leading companies in our industry, explaining how their products work. Our goal is to help you better understand the subtle differences between the technologies so that you can make the most informed decisions when it comes time to buying gear drives, bearings or motion systems.

You can watch *Revolutions* by visiting www.powertransmission.com/tv/. While you're there, you can also catch up on some of our other videos, including our "Ask the Expert LIVE!" feature.

As you're reading this, we'll probably be just returning from Pack Expo, where we plan to see all the technology of the packaging industry in one place. That includes a lot of power transmission solution providers, including the manufacturers of gearmotors, belts, chain, couplings, linear motion and more. We already know there will be a lot of technology presented at Pack Expo, and we're planning to bring information about it back to you. Much of what we learn there will appear in our pages over the coming months.

This season's trade shows have definitely *not* disappointed, but we're also very excited about something coming our way *next* fall. There's a new trade show coming to America—or, rather, the evolution of one we've come to know and love. The American Gear Manufacturers Association has announced that Gear Expo is being transformed with a new identity and broadened purpose. The new show, Motion+Power Technology Expo, will take place October 15-17, 2019 at the Cobo Center in Detroit.

AGMA says that Motion+Power Technology Expo will encompass everything that Gear Expo did, plus a whole lot more. "For the first time, we will bring together manufacturers, suppliers, buyers and experts in the mechanical power transmission, fluid power and electrical drive industries," said Matthew Croson, AGMA President, and Jim Bregi, AGMA Chairman, in the association's official press release.

AGMA has partnered with the National Fluid Power Association to provide a fluid power pavilion, and according to Croson, booths are already starting to fill up. They are also looking to expand partnerships with other organizations and continue to build the show in terms of breadth of products offered.

We think this is great news for you, our readers. In past shows, Gear Expo exhibitors included as many as 50 gear and gear drive manufacturers, with a smattering of additional suppliers in the bearings and other related industries. With the expansion of the show, buyers of mechanical power transmission and motion control components will have even more reason to go. If all goes well, there should be an even wider variety of suppliers to choose from, and even more types of related products.

You can learn more about the Motion+Power Technology Expo by visiting motionpowerexpo.com.

I know that October 2019 seems like a long way off. But it's NOT too early to mark your calendars and make plans to attend. We'll be there, and we hope you will be, too.

A handwritten signature in black ink that reads "Randy Stott". The signature is fluid and cursive, with the first letters of "Randy" and "Stott" being significantly larger and more stylized.

FOR UNSURPASSED QUALITY,
PERFORMANCE AND
VARIETY IN GEAR OILS....



LOOK TO LUBRIPLATE® GEAR OILS

Lubriplate's complete line of premium-quality gear oils has been formulated to deliver unsurpassed performance in a wide range of gear reducers. They meet and exceed the performance specifications of most gearbox manufacturers and interchange directly with most OEM oils. Available products include...

SYN LUBE SERIES 150 - 1000 100% SYNTHETIC PAO-BASED GEAR OILS

- High-performance, 100% synthetic, polyalphaolefin (PAO)-based gear oils.
- Compatible with petroleum-based oils and most seals for easy conversion.
- Available in ISO viscosity grades 150, 220, 320, 460, 680 and 1000.

SYN LUBE HD SERIES HEAVY-DUTY, EXTREME PRESSURE (EP) 100% SYNTHETIC, PAO-BASED OILS

- Super heavy-duty, polyalphaolefin (PAO)-based synthetic gear lubricants.
- Formulated to meet AGMA EP (Extreme Pressure) requirements.
- For Heavy-duty, high load applications where an EP oil is required.

SPO SERIES HIGH-PERFORMANCE, ANTI-WEAR FORTIFIED, PETROLEUM OIL-BASED, INDUSTRIAL GEAR OILS

- Petroleum oil-based anti-wear, rust & oxidation inhibited (R&O) gear oils.
- Can be used with silver alloy, copper, and copper alloy bearings.
- Premium quality, high-performance, petroleum oil-based gear oils.

SFGO ULTRA SERIES NSF H1 REGISTERED FOOD GRADE 100% SYNTHETIC, PAO-BASED GEAR OILS

- NSF H1 registered and NSF ISO 21469 certified - food machinery grade.
- 100% synthetic, PAO-based fluids for food processing and bottling plants.
- Available in ISO viscosity grades 150, 220, 320, 460, 680 and 1000.
- Fortified with Lubriplate's proprietary anti-wear additive **XTREMITY**®.

PGO & PGO-FGL SERIES ADVANCED 100% SYNTHETIC PAG-BASED GEAR OILS

- Ultra High-Performance, Polyalkylene Glycol (PAG)-Based, Gear Lubricants.
- ECO-friendly-Inherently biodegradable, provides long service life, energy conserving.
- PGO-FGL Series is NSF H1 registered and NSF/ISO 21469 certified food grade.

SYNTHETIC WORM GEAR LUBRICANT

- 100% Synthetic, ISO 460 grade, polyalphaolefin (PAO)-based worm gear oil.
- Formulated especially for worm gear applications.
- Provides excellent lubricity and oxidation resistance.

APG SERIES HEAVY-DUTY PETROLEUM OIL-BASED EXTREME PRESSURE (EP) GEAR OILS

- High-quality, petroleum-oil based, extreme pressure (EP) gear oils.
- Meets military specification MIL-PRF-2105E and MIL-L-2105D.
- Conforms to API categories GL-3, GL-4, GL-5, MT-1.

KLING GEAR OILS HEAVY-DUTY, TACKY RED, PETROLEUM OIL-BASED EXTREME PRESSURE (EP) GEAR OILS

- Heavy-duty, tacky, red, extreme pressure (EP) petroleum-based gear oils.
- These tacky, adhesive, extreme pressure oils cling tenaciously to gear teeth.
- Formulated for heavy equipment and heavy service industrial applications.
- Meets military specification MIL-PRF-2105E and API classification GL-5.



Lubriplate
Lubricants

Backed By: **Lubriplate**
ESP

Complimentary Extra Services Package

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

Newark, NJ 07105 / Toledo, OH 43605 / 800-733-4755
To learn more visit us at www.lubriplate.com



Gearing Solutions

HARNESSES RELIABLE ENERGY FOR QED WIND POWER

As the wind comes sweeping down the plains of America these days, it passes through fields of wind turbines. As the energy market turns towards renewable sources of energy, many are turning to wind as an efficient and sustainable source of power. The industry is restricted, however, by the Betz limit, a theory that wind turbines can at most harness 59 percent of the kinetic energy of passing breezes (at 100 percent efficiency, there would be no wind to turn the blades). Then there's the weather factor: even the most streamlined nacelle with perfectly balanced blades is only as reliable as the wind, fickle and changing day to day. In order to maximize electrical production and approach that 59 percent efficiency, wind turbines depend on yaw drives to point the blades in the direction of wind.

QED Wind Power manufactures the Phoenix 20 kW wind turbine systems suitable for farms, residences and small commercial applications. They pride themselves on reliability—if the wind is blowing, the turbines are turning—an ideal they live up to through innovative design and quality American-made parts. Yaw Drives from Gearing Solutions help ensure the turbines are facing the wind, maximizing efficiency and ensuring reliability.

According to Steve Saal, chief operating officer, when QED was looking into manufacturing the Phoenix 20 kW turbine, the competition on the market was all manufactured in China. The team wanted parts made in America, to ensure quality control and better access to repair parts. QED got their wish, and the Phoenix is a veritable tour of American manufacturing: the blades come from Texas, the meteorological sensors from Oregon, and the Yaw Drive from Gearing Solutions in Solon, Ohio.

When researching Yaw Drive suppliers, Saal and his team talked with several suppliers who wanted to sell them what they had on the shelf, missing the details of their specific needs. The engineering staff at Gearing Solutions talked with QED several times before

producing their first prototype.

Gearing Solution engineers helped design the drive shaft to be hardier and more robust, increasing the shaft size and upping the three-phase motor to 1.5 hp. Gearing Solutions also designed the Yaw Drive with grease discs rather than gear oil, to make maintenance easier. After several months of testing and revisions in shaft size and material, the new Yaw Drive was ready.

Gearing Solution's Yaw Drives combine unique roller gear technology with innovative gear construction to optimize the gearbox and minimize size. Gearing Solution's gearboxes are 50 percent shorter than standard and can manage 30 hp and higher, redirecting the turbine alignment so the blades face the wind and produce the maximum amount of energy at all times.

With the addition of an internal roller gear, driver and multiple planets, Gearing Solutions increased load capacities up to 300 percent, an unparalleled power to weight ratio. Aluminum housings make the drive 50 percent lighter, creating a premium weight to torque ratio inside a small profile. The small profile allows the nacelle of the turbine to be as lightweight and aerodynamic as possible. The lighter weight also allows the Yaw Drive to be easily installed and repaired, despite working at height in a

restricted space environment.

Despite their lighter weight, Gearing Solutions Yaw Drives are built to provide years of trouble-free service. The QED tower systems lower the complete tower to ground level for ease of access and increased safety while performing maintenance. Still, lowering the tower causes downtime for repairs.

The Gearing Solutions Yaw Drives' durability reduces downtime, ensuring the turbines are constantly generating energy. Many Gearing Solutions Yaw Drives have been in continued service for more than five years without ever causing downtime in a production turbine.

"We take it for granted," Saal said, "It's like a door in your house that you don't think much about until it falls off the hinges. And this one hasn't fallen off the hinges."

With the reliably durable Gearing Solutions Yaw Drive, QED Wind Power can be sure that their wind turbines are harnessing the maximum amount of wind available. Gearing Solutions' power-to-weight ratio helps ensure the turbines keep the power on for years to come—no matter which way the wind blows.

For more information:

Gearing Solutions
Phone: (440) 498-9538
www.gearingsolutions.com



SK

WHEN SAFETY IS
A REQUIREMENT.
0.1 - 2,800 NM.



RW-AMERICA.COM

R+W[®]
A POPPE + POTTHOFF COMPANY

SKF Actuators

OFFER MODULAR DESIGN FOR SPEED, LOAD CAPACITY AND ACCURACY

SKF CASM-100 electromechanical actuators from SKF Motion Technologies, Inc. have been uniquely engineered with a modular design enabling tailored solutions for a wide range of industrial linear movement and positioning applications. Various modules providing choices among motor types, gearboxes, ball screws or roller screws, and accessories allow for custom combinations of components ideally suited for an application. Standardized interfaces connect the different components to each other for ideal operation of actuators in service.

These actuators deliver optimized performance in speed, load capacity, and positioning accuracy, perform virtually maintenance free and, compared with hydraulic or pneumatic systems, serve as more environmentally friendly and energy-efficient solutions. In addition, they use up to 80% less energy than pneumatic cylinders and 50% less energy than hydraulic alternatives and eliminate any need for constantly running compressors, hoses, and other components.

Applications include robotic cells, handling and packaging machines, sorting systems, manufacturing, and cutting and assembly machines, among many others across industries where reliable, accurate, and precise repetitive motion is required.

Featuring a linear design that can withstand even the harshest operating conditions, CASM-100 actuators are manufactured from high-grade mate-



rials, boast a long service life, and offer superior precision and repeatability. They can deliver a force range up to 82kN / 18,400 lbf. linear speeds up to 890 mm/s, long stroke lengths (up to 2 m / 6.5 ft.), and will support Industry 4.0 technology objectives.

CASM-100 actuators can fit standard industry footprints and can easily facilitate system retrofits or conversions to meet any space and performance requirements. Flexible mounting options and a variety of accessories are available. The actuators are fully equipped to achieve optimal service life, even at very high forces, and ultimately can deliver a highly favorable cost/performance ratio.

For more information:
 SKF Motion Technologies
 Phone: (267) 436-6768
www.skfusa.com



THIN ENOUGH?

- BXR Brakes**
- Up to 480 in-lbs static
 - Up to a 1.125" bore
 - 19 watts or less
 - Produced for over 10 years

Our Innovative design features a very thin profile, reducing weight and saving space.

For more information:
 Call: 800.533.1731
www.mikipulley-us.com



YOU WOULDN'T
SETTLE FOR
PART OF A
HOTEL ROOM.



A hotel with no beds isn't worth your time. Neither is a service provider with only partial drivetrain coverage.

Get the complete solution with Philadelphia Gear. As part of Timken Power Systems, we provide inspections, upgrades, and repairs to every component of your drivetrain.

And with 24/7 on-site assistance from a proven network of ISO 9001-certified service centers, our solution means you'll never lose sleep over partial drivetrain coverage again.

ELECTRIC MOTORS ■ GENERATORS ■ CONTROLS ■ SWITCHGEAR ■ BEARINGS ■ COUPLINGS ■ GEAR DRIVES

SEE THE FULL SOLUTION AT [TIMKENPOWERSYSTEMS.COM/RESTEASY](https://www.timkenpowersystems.com/resteasy)

MOLON

MOTOR & COIL CORPORATION



CERTIFIED
ISO 9001-2015
ISO 13485



Motor Solutions Thru American Innovation

We don't leave the manufacturing and engineering of our products to other countries.

**AMERICAN
MANUFACTURER
EST. 1954**

VISIT OUR WEBSITE:

www.Molon.com

S.S. White Technologies

PROVIDES CUSTOM FLEXIBLE SHAFTS FOR AEROSPACE APPLICATIONS

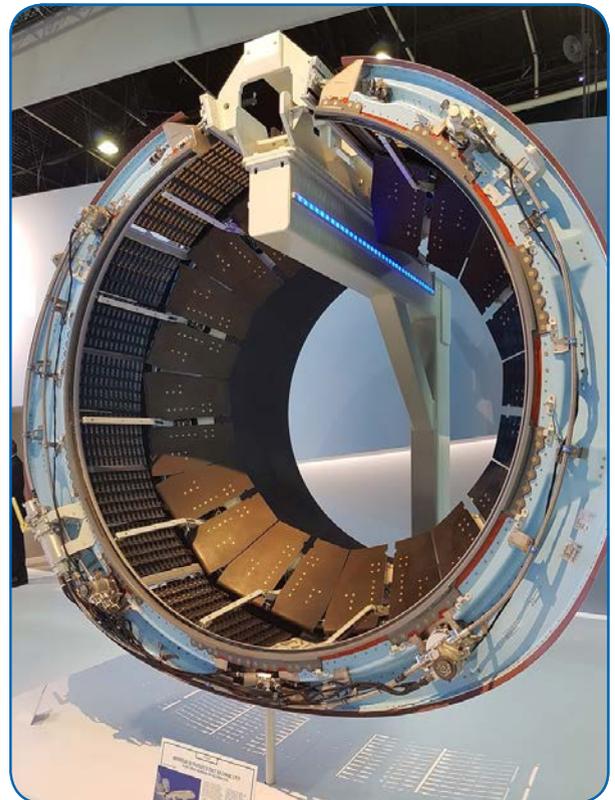
S.S. White Technologies highlights bespoke flexible shaft solutions for aerospace applications. Flexible shafts transmit rotary motion much like a solid shaft, but can be routed over, under and around obstacles where a solid shaft cannot be used. Flexible shafts are used in a variety of applications, including many capacities in aerospace, such as in thrust reverser actuation systems (TRAS), flap and slat systems, variable bleed valves, jet afterburner nozzle control systems, cargo door actuation systems, valve override and many more. S.S. White provides customers with custom flexible shaft solutions designed for specific applications, all backed by S.S. White's wealth of experience and expertise.

While used in many systems on various aircrafts one significant aerospace application is to manually actuate valves if the automatic system in place were to fail. Any number of valves may be manually actuated using a flexible shaft assembly, including Air Turbine Starter (ATS) and anti-ice valves, as well as those applications mentioned in the paragraph above. The ability to control the valves manually in the event of the automated system's failure means the aircraft can still be safely "dispatched" on time, avoiding the time and costs associated with having to find a substitute aircraft.

In addition to the ability of flexible shafts to enable manual overrides of aircraft systems that are usually automated, they are also the preferred rotary motion technology in aerospace applications for a number of other reasons including absorbing shock, dampening vibration and eliminating alignment problems.

S.S. White Technologies produced its first flexible shaft in 1874 for a high-speed dental engine used for drilling teeth. Today, their flexible shafts for aerospace applications are used in thrust reverser, flap, slat actuation systems and manual overdrive systems of air and space craft, in the ammunition magazine drive of the AC-130, in many Airbus & Boeing thrust reverser systems, in the Hubble Space Telescope, on the international space station (ISS) and as part of the V-22 Osprey's rescue hoist system.

S.S. White provides flexible shaft assemblies as part of a custom solu-



tion. Every application in which a flexible shaft is used is different, and S.S. White not only manufactures the flexible shafts, but also provides the technical expertise to create solutions to engineering challenges.

For more information:

S.S. White Technologies
Phone: (732) 474-1700
www.sswwhite.net

Amacoil

LINEAR MOTION DRIVE PROVIDES FLEXIBILITY AND PRECISION

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

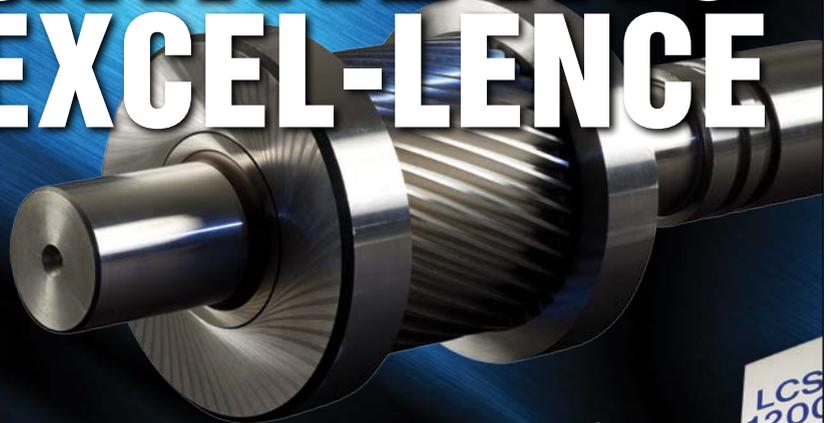
The linear movement of the drive head is controlled via software and monitored by sensors feeding back to an electronic control unit. The Precision Motion Drive stores up to 20 programs that may be recalled at the touch of a button. While meeting application requirements for most precision linear movement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

The Precision Motion Drive System offers flexibility with regard to customized linear movement of the drive nut. Stop/start, travel direction, linear pitch, travel speed, repetitive processes, ramp up/down and essentially all other variables pertaining to drive nut movement may be programmed into the system to meet precision linear motion application requirements. The core PLC/software package may be used to control multiple Uhing Model RG drive stations making it unnecessary to invest in multiple systems in order to help sustain high production rates.

A stepper motor controlled by a Siemens S7 PLC is included in the package. Fast, simple operation is enhanced with intuitive prompts displayed on a touch screen control panel. The shaft on which the Precision Motion Drive runs is smooth case hardened steel. There are no threads which makes the system useful in applications where



GRINDING EXCELLENCE



WE EXCEL at high speed, high accuracy generating grinding for all applications:

- Gears as large as 1200 mm in diameter and module 12.
- With technology and software to grind "Beveloid" (conical) gears, and tip and root relief without special dressing diamonds.
- We also excel at grinding gears as small as 2.0" in diameter.

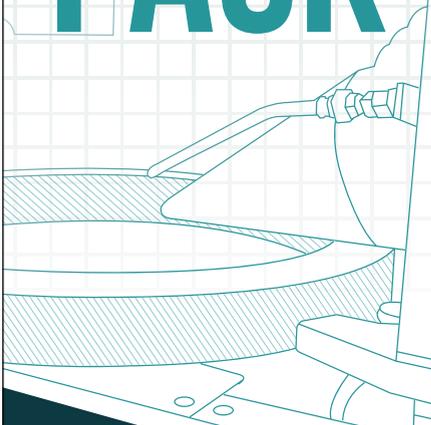


Ready to Excel?
Contact:



815.623.3414 / www.excelgear.com

FORGING AHEAD OF THE PACK



MADE IN THE
USA

**Fast.
No Fine Print.
No Premium.**

At McInnes Rolled Rings, we provide quality products, shipped fast. And we partner that with exceptional customer service to forge the perfect partnership with our customers.

**McINNES
ROLLED RINGS**

1.877.736.4409

www.McInnesRolledRings.com

particulate contaminants could fall into threads causing jams or clogs. The shaft rotates in one direction only making it unnecessary to purchase a reversible motor. Drive nut travel direction, linear pitch and other motion parameters are controlled by the angle

of the rolling ring bearings inside the drive unit which in turn is controlled by user programming.

For more information:

Amacoil (Uhing)
Phone: (610) 485-8300
www.amacoil.com

GAM

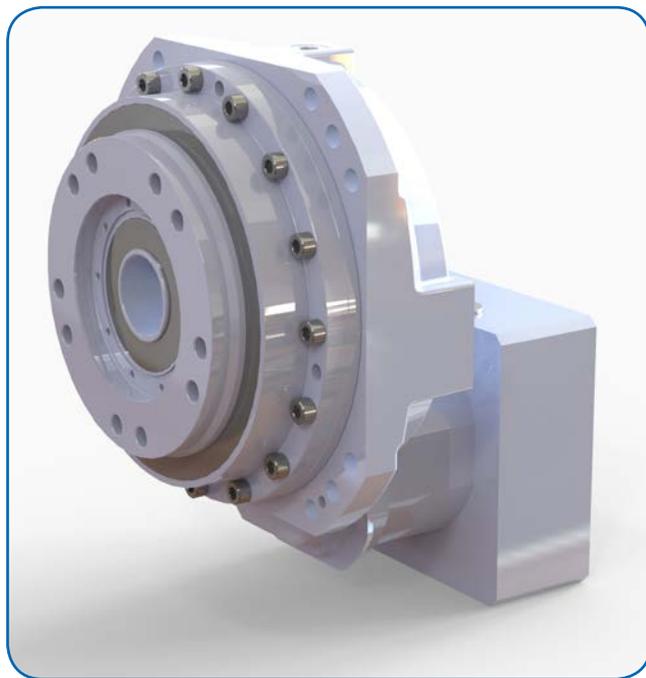
RELEASES ZERO-BACKLASH ROBOTIC GEARBOXES

GAM announces the release of the new GPL zero-backlash planetary gearboxes. The new gearboxes provide high precision and rigidity for horizontal and vertical robotic and motion control applications.

Featuring a patent-pending design, the backlash will not increase over the lifetime of the gearbox, maintaining high precision and eliminating periodic adjustment. The GPL series is available in seven sizes with ratios from 36:1 to 200:1.

“The GPL expands GAM’s offering into zero-backlash gearboxes,” said Randy Kuper, regional sales manager at GAM, “and with less than 6 arcsecs [0.1 arcmin] backlash, the GPL has the highest accuracy on the market.”

Output options for the GPL series include a solid flanged output (GPL-F) and a hollow shaft flanged output (GPL-H). The GPL series can be used in a variety of applications, from robotics and automation to medical equipment, where zero-backlash, high tilting and torsional rigidity and long life are required.



For more information:

GAM
Phone: (888) 426-7117
www.gamweb.com

Nexen

EXPANDS PRECISION ROTARY INDEX LINE

Nexen Group, Inc. introduces the Motor Ready Sealed (MRS) precision rotary indexer. The MRS maintains the benefits of the company's existing patented precision roller pinion drive design - zero backlash, high precision, high torque, and high acceleration - while delivering significant new benefits. A high roller pinion-to-gear ratio allows users to direct drive the system with the addition of a servo motor - eliminating the cost of a reducer. This also reduces engineering and installation time. For high load applications, the customer can drive the system with a reducer/motor combination. Additionally, the gear-to-pinion reaction loads are fully supported so the servo motor shaft is not subjected to radial loading, which eliminates the need for costly high output capacity reducers in high load applications. All of these features reduce engineering and installation time. The MRS is ideal for precision rotary indexing applications such as machine tool, and semiconductors, robotics, automated welding, medical packaging, assembly, cutting systems.

For more information:

Nexen Group, Inc.
Phone: (800) 843-7445
www.nexengroup.com



Motors & Gear Drives

Sesame Motor lines of AC motors, gear motors, gear reducers and servo planetary gearheads offer a wide variety of size, precision levels and configurations to satisfy the full range of motion control applications. With years of manufacturing experience, we can assist in selecting the best part for your need and customization to your exact specifications.



www.sesamemotor.com



America Exclusive Agent
DIEQUA
Corporation

630-980-1133

www.diequa.com



Quicksilver

EXTENDS HYBRID SERVO MOTOR FAMILY

QuickSilver Controls has released the X-series 34 Frame SilverMax Integrated Servo Motor Family. This extends the company's hybrid servo product line.

QCI-X34 series operate from 12.5 v to 72 v (processor section 12 v to 48 v). Mechanical power out levels up to 850 W. X34CK-1 and -2, and X34CT-1 have been added as a lower cost option for the mid power range. The X34HC-x family covers the upper power and torque range. These hybrid servos use advanced techniques to obtain a high efficiency of up to 80 percent over up to a 4:1 speed range (greater than 70 percent over a 10:1 speed range) This is including both the motor and the driver. This is the result of a combination of a very high torque constant motor with a very low winding resistance, and the application of field-weakening techniques. The high torque constant allows this motor to produce full continuous power by 500 rpm for the 48 v drive level, and to continue this same power level through 2,000 rpm.

These hybrid servo motors are designed with an interior permanent magnet rotor, (also called buried magnet), allowing for field weakening. This lets us extend the high efficiency operation over a wide range by effectively turning down the torque constant to enable higher speed operation at a given voltage—keeping the motor back-EMF near the input voltage over a wide range of speeds. In contrast, conventional servo motors use low permeability face mounted magnets in their rotors which make it much more difficult to use field weakening techniques, thus their region of high efficiency operation is limited to very near their optimal speed where back-EMF nears the input voltage. Operate conventional servos at 20 percent of their optimal speed, and they will have 20 percent of their optimal efficiency at best. Operate conventional servo motors them at peak torque and their heating rapidly increases - to the point that they can only sustain for typically a few seconds - and their efficiency



plummets. (Both motors compared at 48 VDC; peak torque for conventional motor equaled the continuous torque rating of the X34HC-1 system.)

This means if you are using most conventional servo motors to direct drive a belt or lead screw applications, then it is likely the motor will not be near their power rating, and the efficiency will be poor. Peak torque for conventional servos will typically be available for only a brief 1 to 5 seconds before the windings are nearing maximum temperature. This is not surprising as conventional servo motors get their peak torque by overdriving the motor by a factor of 3x to 10x the sustainable current - which causes 9x to 100x the resistive heating as compared to their continuous current rating. The hybrid servo, alternatively, produces high torques in direct drive operations while running at their nominal continuous currents.

For more information:

Quicksilver Controls, Inc.
 Phone: (909) 599-6291
www.quicksilvercontrols.com

Ruland

OFFERS LEFT HAND THREADED SHAFT COLLARS

Ruland has expanded its offering of threaded shaft collars by adding inch and metric left hand threaded styles to give designers more flexibility to work with standard off the shelf components. They are available in one- and two-piece clamp styles in steel and stainless steel with bore sizes ranging from 1/8 inch to 2 1/4 inches and 4 mm to 30 mm.

Left hand threaded shafting is commonly used to reduce the risk of components coming loose in rotating applications and as a safety measure to prevent the unintended removal of critical components. Ruland manufactures left hand threaded shaft collars in one- and two-piece styles to meet the needs of equipment manufactures. Threaded shaft collars are designed to provide higher axial holding power than round bore collars of comparable size. They are well suited for guiding, spacing, stopping, mounting, and component alignment in industries such as packaging, printing, semiconductor and solar. Two-piece type allows for simple installation or disassembly without the need to remove adjacent components.

Ruland double taps threads to ensure a precise and burr-free finish allowing for easy installation and removal, proper fit, and extended shaft life. Equipment manufacturers benefit from the tightly controlled face to bore perpendicularity of Ruland shaft collars ($TIR \leq 0.002$ inch or 0.05 mm) which is critical when they are used as a load bearing face or for aligning components such as bearings or gears. Forged screws test beyond industry standards to ensure maximum holding power.

For more information:

Ruland Manufacturing Co., Inc.

Phone: (508)

www.ruland.com



Motor Design Ltd.

EXPANDS E-MAG MODELING COVERAGE

Motor Design Ltd (MDL) (located in Wrexham, U.K.) has significantly expanded its Motor-CAD version 11 E-Mag (Electro-Magnetic) motor design simulation program by adding a Switched Reluctance Machine (SRM) E-Mag module to its current BPM (Brushless Permanent Magnet) & Synchronous AC Motor (SYNC) & Induction (IM) E-Mag modules of Motor-CAD v.11 simulation program.

The SRM E-Mag module enables the design & analysis of electronically commutated reluctance motors & generators using motor sizing and performance characteristics generated by Motor-CAD. The magnet less SRM motor possesses a superior environment performance with respect to higher thermos & shock conditions.

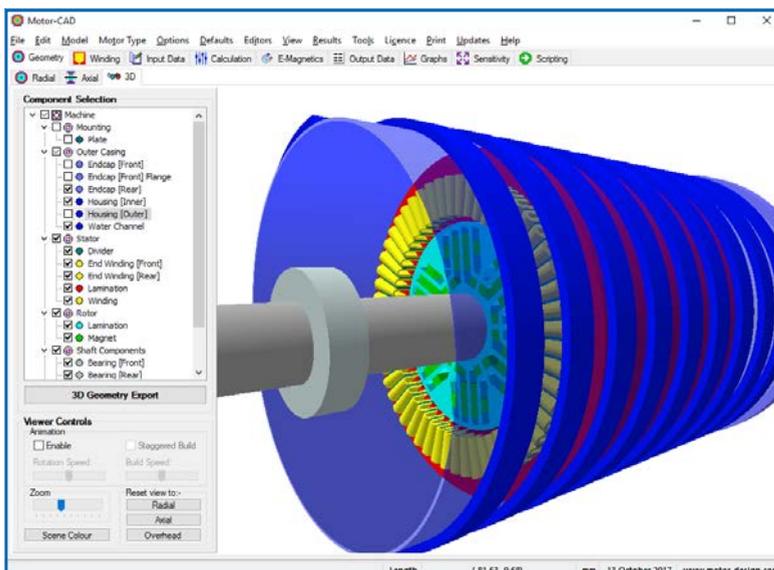
The FEA electromagnetic solver and a parameterized controller model, output data such as current, power and torque wave forms are produced quickly and easily, allowing fast design optimization processes.

For more information:

Motor Design Ltd.

Phone: +44 (0) 1691 623305

www.motor-design.com



The Consistency Game

A Look at Gear & Gear Drive Lubrication Performance Improvements

Matthew Jaster, Senior Editor

Everything they say about gears and gear drives is absolutely true. From automobiles to farm machinery, appliances to wind mills, aircrafts to mining equipment, gears today are asked to run more efficiently, cost less money and provide longer life. Those involved in MRO (maintenance, repair, operations) will tell you that lubrication plays a large role in the overall success of gears and gear drives.

The challenge is that with so many different applications, the lubrication methods and procedures vary widely and must often be optimized through experience with each one. Still, no matter the application, the end game is minimizing lubricant-related breakdowns in the field. This is why a transparent and consistent understanding of gear and gearbox behavior can go a long way in keeping your equipment running effectively.

“Consistency is key so that as many variables as possible can be eliminated, while focusing on controllable factors during the optimization process, such as lubricant type, filtration methods, method of lubrication, and re-lubrication quantity and



Photo courtesy of Lubriplate.

frequency,” said Daniel Roberts, technical services manager at Lubrication Engineers. “When these controllable factors are isolated, adjustments can be made and monitored for improvements in overall performance to optimize the lubrication procedure for each unique application.”

What’s my Focus?

So what are some of the most important factors to consider when selecting

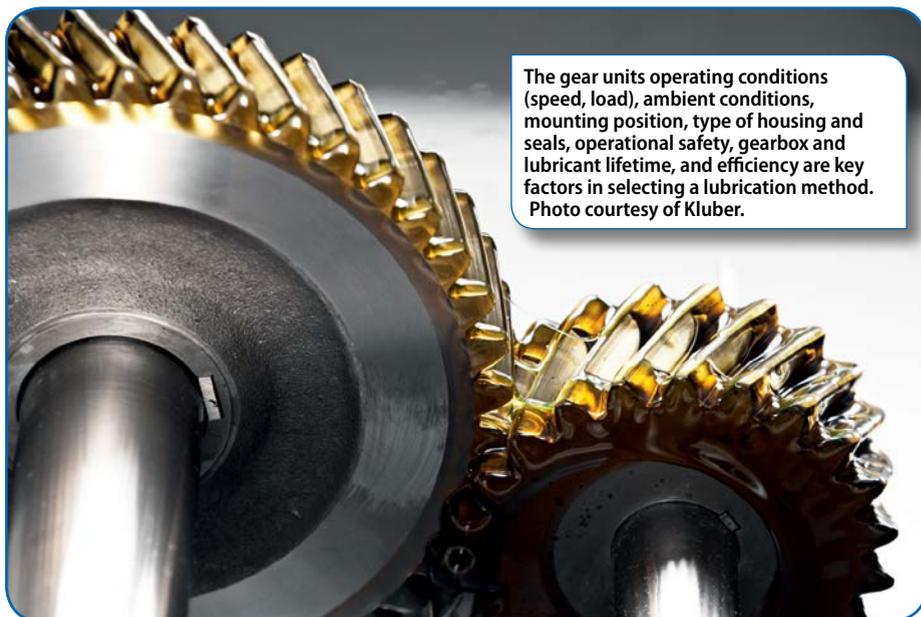
a lubrication method for your gears and gear drives?

Joe Sitta, business development manager, power transmission and gear products at Kluber, said that the gear units operating conditions—including speed and load—ambient conditions, mounting position, housing and seal types, operational safety requirements, lifetime requirements and efficiency all play a role in selecting the best lubrication method.

Jim Girard, executive vice president and chief marketing officer at Lubriplate agreed. “The benefits of selecting and following a consistent lubricating procedure is that it improves gearbox life and allows for longer drain intervals.” Girard also said that it’s important to follow the OEMs recommendation for best results.

For Roberts, lubricant selection is likely the most important factor overall in lubrication of gears and gear drives. “It is in the end user’s best interest to select a lubricant with the appropriate viscosity, base oil type, and additives that can provide adequate protection for the specific application,” Roberts said.

“One example is the comparison of lubricating an industrial gearbox to



The gear units operating conditions (speed, load), ambient conditions, mounting position, type of housing and seals, operational safety, gearbox and lubricant lifetime, and efficiency are key factors in selecting a lubrication method. Photo courtesy of Kluber.

lubricating a differential or final drive in a haul truck used in mining applications. The lubricant selected in industrial gearbox applications may be an ISO 220, extreme pressure type of gear fluid meeting DIN 51517-3. Because of the types of wet brakes/clutches that operate using the same gear fluid as the gears and bearings within the final drives and differentials in mining applications, industrial gear lubricants cannot be selected for these applications. Generally, TO-4 fluids are required in these applications, as the fluid is required to develop friction coefficients for the specific materials used in the wet brakes/clutches," Roberts said.

Filtration practices are also crucial. Roberts said that keeping a gear lubricant clean and dry during its use can prolong the life of the lubricant itself, as well as the equipment that it is protecting.

"We have seen instances of elevated bearing operating temperature in industrial gearbox applications, where bearing temperature reductions of up

to 30 degrees F have been observed simply by moving to a more appropriate gear fluid and implementing the use of periodic kidney loop filtration to keep the oil clean and dry in-service. This reduction in bearing operating temperature is attributed largely to the reduction of abrasive wear occurring in the application," Roberts added.

In addition to optimizing the lubricant type, re-lubrication frequency and quantity, when the use of an intermittent automatic spray system is relied upon to apply lubricant to the gear set, the gear set should also be monitored to ensure that it has appropriate lubricant coverage across its entire facewidth.

"Sometimes, there are too few nozzles to ensure appropriate coverage for larger gear sets. These nozzles can also become plugged over time due to lubricant buildup, or they can become "cocked" or no longer properly aimed at the gear. Both factors can affect the spray pattern of lubricant to the gear. In most instances, nozzles are oriented to spray the bull gear immediately as it

comes out of contact with the pinion. In these instances, the operator should ensure that the intermittent spray cycle time lasts for at least one revolution of the gear, but preferably two revolutions to ensure adequate coverage. An air afterspray, or air purge, is recommended after each spray cycle to keep nozzles from plugging over time, to ensure that the gear set always gets the appropriate lubricant coverage that it needs," Roberts said.

Some Gears are Better than Others

Unfortunately, not all gears are created equal. Therefore, certain gear types are more challenging to lubricate than others.

"Gears types with high sliding speeds and regimes of mixed friction are the most challenging," said Sitta. "This type of gearing results in high shear stress on the lubricant requiring good extreme pressure and anti-wear additives."

Both Girard and Roberts also cite worm gears as challenging when it

spiral bevel gearboxes
🔍

Did you mean: **DieQua Corporation?**

The search is over!

For quality spiral bevel gearboxes that provide improved performance, high reliability and easy maintenance, look no further than DieQua.



- 9 sizes
- 15 ratios
- Power capacities from 1-300 HP
- Low Backlash
- Customizable
- Mounting on all 6 sides

To finally find what you're looking for, check us out on the web, or give us a call.

diequa.com/pte 800-430-1439

DIEQUA
Corporation

comes to lubrication.

“There are several types of worm gear drives, each with their own set of challenges. The simplest type of worm gear set is a steel, cylindrical worm gear in mesh with a steel bull gear. These types of gear sets can typically operate on an extreme pressure type of gear lubricant. It gets more challenging when single (hourglass worm gear shape) or double enveloping (hourglass worm gear shape and concave bull gear teeth) worm gears are introduced into

the mix, often with brass or bronze sacrificial bull gears,” said Roberts.

Due to a combination of elevated temperatures and extreme sliding loads at the microscopic asperity contacts, EP gear lubricants are typically avoided as they can become corrosive to yellow metals and cause premature wear in the sacrificial gear. These types of worm gear drives typically require a lubricant that can provide greater protection against these extreme sliding loads. This typically includes synthetic

industrial oils (non-EP), compounded gear oils (which include synthetic fatty acids), or polyalkylene glycol (PAG)-based gear lubricants to facilitate more efficient sliding in the worm/bull gear interface, according to Roberts.

Since operating temperatures, loads on the gear teeth, gear speeds, and gear metallurgy vary by application, it is important to choose an appropriate lubricant that is in accordance with OEM specifications to prevent premature gear failure as mentioned earlier.

“OEMs usually perform the necessary testing to determine which gear lubricant types are appropriate for their equipment under expected service conditions and duty cycles. Unfortunately, many end users take lubricant selection into their own hands and perform their own experiments with various lubricant types, which puts their equipment at unnecessary risk,” Roberts said.

Keeping an Eye on the Equipment

Many of the companies involved in gear and gear drive lubrication don't just offer products and disappear to the next sales call. It's important to have a failure/wear analysis program in place to monitor the machines.

“Consistent analysis of the gear fluid helps detect wear in metals,” said Girard. “We offer lubricant analysis with tracking at no charge to better serve our customers.”

Oil or grease analysis is a method of condition monitoring that tells you about the operating condition of the gearbox. This is essential to predict malfunctions or possible breakdowns.

“Ideally, the result of the analysis will confirm if there is an existing problem with a component in the unit and this will allow time to schedule a preventive procedure to correct the situation,” Sitta said.

Roberts said that oil analysis can also tell you valuable information about the current condition of the fluid in-service, as well as the equipment itself.

“The most common routine monitoring test slate that we recommend for gear drives is simple, yet very effective. It includes viscosity, acid number, water contamination, spectroscopy

YOUR BEST SOURCE FOR METRIC

MOTORS, GEARBOXES & COOLANT PUMPS



LAFERT
NORTHAMERICA

Toll Free: 1.800.661.6413 Fax: 1.905.629.2852
www.lafertna.com Sales1@lafertna.com

Copyright Lafert North America 2017. All rights reserved.



analysis (wear, additive and contaminant metals), and particle quantifier,” Roberts said. “Through viscosity and spectroscopy analysis alone, we often find that a lower viscosity lubricant has been introduced into a gear drive, causing premature gear and bearing wear. Other times, we find that viscosity and acid number have become elevated, which are indications that the fluid has oxidized and exceeded its useful life.”

“Sometimes, through cyclic fatigue (three possibilities are old equipment, excess loads and misalignment) particle quantifier identifies ferrous wear particles that are too large for the standard spectrometer to read or, in other words, would have been missed had it not been for the particle quantifier. For this reason, we recommend including particle quantifier in the routine test slate for critical gear drives. If ever a spike is observed while trending wear rates, analytical ferrography should be considered. While this is more expensive than the routine test slate, it can offer valuable information about the size and type of wear that is occurring, rather than just that there is wear occurring,” Roberts said.

Synthetics and Energy Efficiency

All companies interviewed for this article discussed how upgrades to reliability programs, routine oil analysis, maintaining proper fluid levels and utilizing in-house testing to confirm product viability has improved gear and gearbox reliability over time.

An additional factor to consider is the energy efficiency of synthetic lubricants.

“In most all cases the use of a synthetic lubricant is the best choice because it improves the operating efficiency of the gears and bearings, reduces the oil temperature resulting in slower ageing of the oil and also extends the oil change intervals,” Sitta said.

Roberts believes the importance of energy efficiency depends on the goals and preferences of plant personnel; preventing downtime due to equipment failure is typically more of a motivating factor for those seeking to improve lubrication and maintenance practices.

Potential cost savings by reducing downtime are generally greater than those achievable with energy reduction. “However, when equipment is operating properly, and lubrication practices are optimized, significant savings are also possible with increased energy efficiency,” he added.

He continued, “Perhaps the time when friction is most prevalent is during equipment startup, when boundary lubrication exists. During this time, the viscosity of the lubricant and its additive

package play a significant role in the amount of friction that two opposing surfaces will experience. Load and surface roughness also come into play, but there is little that can be done to change that, regardless of lubricant selection.

“Selecting a lubricant of the proper viscosity and additive package can reduce the friction coefficient between opposing surfaces, thus affecting energy consumption required to operate the gear drive. Synthetic gear lubricants often have naturally lower traction



The Power of One²

Your Objective:

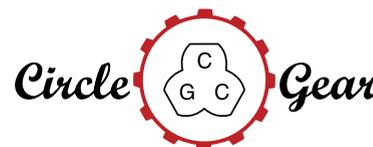
One face in perfect alignment with another. *For infinity.*

No problems. No distress. No delays.

That’s the same objective you have for choosing your gear producer. Circle Gear’s objective is to engage with every customer’s objectives.

- ▶ **One to 1000 gears**
- ▶ **Customer designed or reverse engineered**
- ▶ **Gearbox repair, rebuild or redesign**
- ▶ **OEM or end-users**
- ▶ **ISO 9001:2015 Certified**

1501 S. 55th Court, Cicero, IL 60804
 (800) 637-9335
 (708) 652-1000 / Fax: (708) 652-1100
 sales@circlegear.com
 www.circlegear.com



Spiral and Straight Bevel Gears (*Cut, Ground or Lapped*) • Spur Gears • Helical Gears • Long Shafts • Herringbone Gears • Involute and Straight Sided Splines • Internal Gears • Worm and Worm Gears • Racks • Sprockets • ISO Certified



Partnering with QualityReducer to provide Gearbox repair, rebuilding and reverse-engineering.

coefficients than petroleum hydrocarbon-based fluids and can offer enhanced energy efficiency. A combination of these factors can have a synergistic effect on energy costs, especially where low voltage, high horsepower electric motors are driving the gear drives. When a plant has several gear drives that use the same electric motors, even a fraction of a percent of amperage reduction can add up to significant savings, which will outweigh the cost of using a premium lubricant, including the higher price of synthetics,” Roberts said.

In the end it comes down to the old adage, “You pay for what you get.” Shortcuts and cost-savings do not translate into efficient manufacturing.

“OEMs and end users that invest in high-quality lubrication methods will simply allow gearboxes to last longer and their customers will realize increased productivity,” Girard said.

It Still Comes Down to Science

Roberts said that OEMs are requiring next generation fluids to have much better ancillary performance with respect to the gear set in terms of oxidative and thermal stability, seal compatibility, bearing protection and fatigue life, compatibility with paints and corrosion-resistant coatings, as well as impact on the environment.

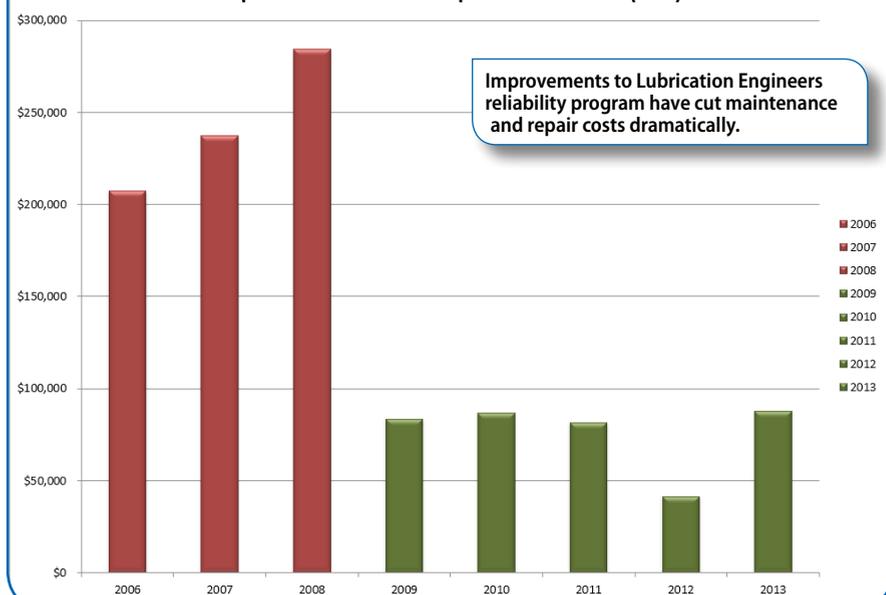
“Many of these next gen fluid requirements stem from the use of smaller fluid sumps, which puts higher thermal stress on the fluid. Also, in many cases, gearboxes are selected for applications where actual loads are approaching the upper end of design loads, if not exceeding them. In these cases, the fluid must be able to tolerate the higher thermal stresses, as well as the higher loads that it is subjected to, while still providing the expected service life of the lubricant as well as protection to the equipment. Because of greater demands of fluid life and fatigue life of bearings and gears, improved fluid cleanliness is an area that is receiving more attention with these next generation fluids,” Roberts said. “Due to so many uncontrollable variables, after lubricants have left the manufacturing facility, it is not practical or economical for fluid manufacturers to deliver extremely clean oil. In the future, the importance of fluid cleanliness to meet these higher demands



Spray patterns before (top) and after (bottom) Lubrication Engineer's Pyroshield Syn XHvy Open Gear Lubricant was introduced. Photo courtesy of Lubrication Engineers.



Repairs & Maintenance Spend 2006 - 2013 (U.S.)



Improvements to Lubrication Engineers reliability program have cut maintenance and repair costs dramatically.

will influence end users to increase filtration efforts onsite to keep the in-service lubricants cleaner and dryer.”

Regarding efficiency improvements and sustainability, Sitta believes that new formulations of lubricants for gearbox applications are currently available with water as a main component of the formulation.

“This has shown a marked improvement in reducing the traction coefficient, lowering the operating temperature and improving the efficiency,” Sitta said. “In addition, the biodegradable lubricants for marine applications for example are improving with improved performance of Ester base oils.”

Lubrication Trends and Considerations

Most lubrication methods have been around since the dawn of the industrial revolution; however, technology continues to improve, and new innovations, or tweaks to these conventional methods, are often introduced. Roberts discussed two examples:

Technology in the automotive industry: Detroit’s new tandem rear axles with Axle Lubrication Management (ALM) System reduces fuel consumption by regulating the oil level at the ring gear to reduce fluid friction between the gear and the gear oil. This is accomplished via the use of a valve that has been integrated into the ring gear cover.

Remote-mounted sensor technology: Monitoring your equipment’s health accurately and efficiently can be an effective way to help decrease downtime and minimize unforeseen costs. This is now more important than ever, as system requirements continually demand improved performance and greater availability.

“Bluetooth technology is working its way into sensors that can wirelessly transmit data via email or text notifications, including low level warnings, changes in pressure, temperature or humidity conditions, and fault indicators. As this technology develops, we foresee that it will become widely popular, as users will be able to optimize asset and system performance remotely based on real-time conditions, especially in remote areas that are difficult, or dangerous to access,”

Roberts said.

Much like gear manufacturers, lubrication companies will need to pay close attention to the changing paradigm taking place in the automotive industry.

“The greatest change coming to the range of automotive lubricants is the trend toward more electric vehicles,” Sitta added. “The trend is moving toward specialty greases and synthetic lubricants for high-speed, electrically-driven gearboxes.” **PTE**

For more information:

Kluber Lubrication
Phone: (630) 647-4104
www.klueber.com

Lubrication Engineers, Inc.
Phone: (800) 537-7683
www.lelubricants.com

Lubriplate Lubricants Co.
Phone: (800) 733-4755
www.lubriplate.com



Where AEROSPACE Gets a LIFT

Aerospace is striving to reach new heights. We're a power in aerospace gear production, with an unparalleled precision gear facility, over 60 years of aerospace gear experience – and Aerospace AS 9100 compliance.

Aim higher, go further, with aerospace gears from Forest City Gear.

FOREST CITY GEAR

Excellence Without Exception

815.623.2168 | www.forestcitygear.com

Gearmotors Pulling, Pushing — and Controlling — Their Weight

Industrial mainstay adapts to remain relevant in a 4.0 world

Jack McGuinn, Senior Editor

As manufacturers wend their way through what is now the increasingly vertical 4.0 world of industry, more of what were once-essential manufacturing components and processes find themselves on the endangered species list.

But not gearmotors. In some industries, they're becoming more relevant than ever. For example, as more hydraulics-driven applications transition to electronic actuators, gearmotors are taking over. In addition national defense and automotive are just two major sectors where geared actuators are specified, especially for custom applications. Indeed, if high force is required, gear or ball screw actuators remain the way to go.

This is not to say that gearmotor makers don't have concerns and conditions to deal with; some very real ones include:

- Growing gearmotor manufacturer and customer cost concerns in light of the escalating China trade war, which will directly affect magnet prices (brush and brushless DC, as well as IPM AC) and commutators (brush DC) — not to mention tariff-related rising steel and aluminum prices.

Looking for more insight, we asked some industry experts for their views on gearmotor usage and continued relevancy.

For instance: what is the relevancy of gearmotors relative to hydraulics used in electronic actuators? Is the needle pointing up or down? What would be their most common industrial application? It depends — as almost always — on the application. Is brute force needed — or motion-controlled finesse?

“Just about every OEM application you can think of is trying to accomplish greater flexibility, precision and efficiency, says John Morehead, principal consultant for Motion Mechatronics. “That’s why there’s a strong move to replace hydraulic actuators with electric motor-driven actuators. Rather than the brute force of a hydraulic motor driving various linkages, the move today is toward distributed motion with individual smaller, more efficient electric gearmotors. A notable example is agricultural precision planting to increase yields and reduce costs for farmers. Not only can the maintenance of a complex system of jackshafts, sprockets and chains be replaced with individual gearmotors; each one can be controlled individually to maximize yield for each row planted, which is important when the multi-row planter turns corners or follows curves. The elimination of hydraulic fluid leaks and contamination is a bonus.

“A wide range (of relevancy), says George Holling, CTO, Rocky Mountain Technologies and *Power Transmission Engineering* motors blogger. “We are working on missile actuators where size, volume and weight are the prime concerns, and gearmotors do well. Gearmotors now start to match the power density of hydraulic systems on an overall system comparison. The distributed system and the independence between actuators vs. a single hydraulic reservoir add a high level of redundancy and potentially also lower overall system and installation cost, as wires are lighter and cheaper to install than hydraulic lines.”



This Chinese-made gear motor is a switched reluctance traction motor with internal plastic gear (Photo courtesy Rocky Mountain Technologies).

Looking for more, we asked about the efficacy of gearmotors/actuators in, for example, fly-by-wire and drive-by-wire applications requiring high power densities.

Holling responds that “The total efficiency is the actuator efficiency * gear efficiency. As motor speed increases, the motor efficiency will increase — especially p to 2KRPM-3KRPM at higher speeds it will drop again. Gear efficiency is

For Related Articles Search

garmotors

at www.powertransmission.com

approximately 90%; most gear ratios are 3:1 to 6:1.”

Morehead believes that “High-power density brushless DC gearmotors, combined with optimized efficiency gearing, is becoming the standard in autonomous warehouse robots. Brushless DC is not only more responsive but also more efficient and compact, with virtually limitless lifetime expectations compared to conventional brush DC gearmotors.”

Returning to automotive applications, is it relevant to wonder what, if any, part gearmotors play in electric vehicles? To what extent do potentially deal-breaking things like size, weight and gear cost apply?

“EV motors typically have a fixed reduction gear to reduce the motor size,” Holling states. “Increasingly, OEMs are looking to increase the motor speed to 12KRPM or more to save motor cost. There will be an optimal point where the total cost of motor + gear is minimized.”

And what of any advances of note in plastic-geared gearmotors/drive systems? Available information is a bit sketchy, but Holling reports that he’s “seen a durable, plastic-based gear system out of China: lightweight, low cost and somewhat durable. And we know of at least one Chinese manufacturer that integrated a plastic gear into a traction motor for small 3-wheel delivery trucks. I do not know if this panned out though.”

China’s mention returns us to the tariffs/trade war issue. Sure, it is all very political and perhaps uniquely Trumpian, but this is a “guns-and-butter,” all-hands-on-deck issue for certain manufacturers — like those of gearmotors.

Morehead allows that “Unexpected tariff burdens are a fact of life today, where gearmotors possess content sourced from China and has prompted U.S. gearmotor manufacturers to look toward other low-labor-cost APAC (Asian-Pacific) countries for component or motor sourcing. Of course, the warning signs have been there for years and basic global economics foretell that the advantages of low labor and material costs are fleeting as economies develop. If all you make today is a standard-design gearmotor, you’ve set yourself up for global commoditization.

“While it’s more important today than ever to provide the best application and design engineering support, along with highest quality and shortest lead times, it is becoming evident that customers are looking for more than just a gearmotor. Those gearmotor manufacturers who can also provide motor controls, cabling, brakes, encoders, brackets, shielding, enclosures and anything else customers will find advantageous to purchase as a sub-assembly will be rewarded with a stronger customer relationship and increased insulation from competition.”

For Holling, in much the same vein, “These motors are becoming a commodity item with shrinking margins and strong price competition from China and others, which makes them less attractive to U.S. producers,” says Holling. “Unless the supplier can offer a value-added which commands better margins, the U.S. is not competitive.”

Meanwhile, seemingly, everything is a moving target in today’s automated, bot-driven world. And highly sophisticated, software-driven motion *control* is now manufacturing’s meat du jour. So where do, say, brushless DC motors fit in?

“Integrating the control required to make the brushless motor turn with the motor only makes sense in terms of eliminating costs of cabling and enclosures, while simultaneously eliminating electrical interference issues,” says Morehead. “In addition, the OEM’s installation time and cost are reduced and field servicing, which is always a burden, is greatly simplified. The OEM’s greatest source of frustration is when a motor-and-drive problem arises and they’re faced with finger pointing from two separate sources. Simple speed controls are just the first step and the gearmotor manufacturer’s controls capability needs to eventually expand to positioning and networking to ensure being able to offer the highest-value, differentiated gearmotor solutions.”

Holling explains that “Integrated controls can simplify the machine design, wiring costs etc. Thus, an integrated controller is a prime example of a value-added service that customers value and pay for. An integrated controller can also reduce design time and cost for equipment. Allow for future upgrades and field replacements (repair with different or generic components), and the reduced wiring and connections can potentially improve reliability.”

“These motors are becoming a commodity item with shrinking margins and strong price competition from China and others, which makes them less attractive to U.S. producers,” Holling says. “Unless the supplier can offer a value-added which commands better margins, the U.S. is not competitive.”

For more information

John Morehead, principal consultant
Motion Mechatronics
104 E. State Street #412
Sycamore, IL 60178
Cell: (224) 401-2161
motionmechatronics.com

George Holling, CTO
Rocky Mountain Technologies
P.O. BOX 210
Basin, MT 59631
rockymountaintechnologies.com

Direct Drive and Hybrid-Servo Motors — with or without Gears

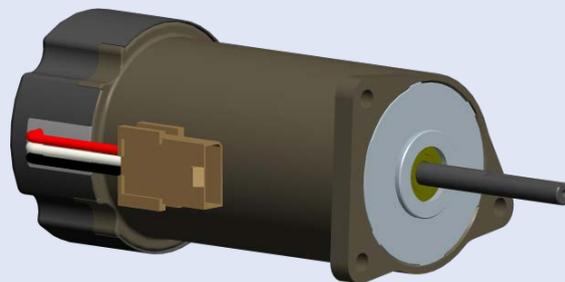
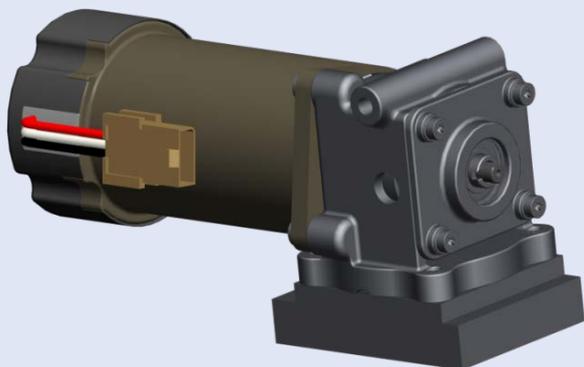
Newer-technology direct drive and hybrid-servo-type motors are enjoying increasingly more pervasive market share. The following is from a company—QuickSilver Controls Inc. (QCI)—focused on making these types of motors. But they do have some users that add gearheads to the motors. They have also worked with customers using harmonic drive gearmotors for certain applications as well. These comments are from Don Labriola, QuickSilver president and founder.

On relevancy of gearmotors relative to hydraulics used in electronic actuators; most common industrial applications

- We have seen the replacement of hydraulics with electronic drives in molding applications due to reduced fire risk and reduction of environmental recovery costs associated with spills of hydraulic fluids. In entertainment systems, the high power density of new electronics systems as well as the high efficiency has allowed removal of the hydraulics in many systems, preventing both the environmental cleanup as well as customer exposure to hydraulic vapors which can result from small pinhole leaks. The degree of maintenance and requirement of maintenance knowledge appears to be significantly lower for the electronic actuators, the electronic actuator having longer periods between maintenance.

On efficacy of gearmotors/actuators in applications requiring high power densities

- Both high power density and high efficiency are needed in warehouse automation powered by batteries or other storage, as the ratio of operations time to charging time sets the effectiveness of the system. Efficiency either less batteries or longer time between charging, or both. Starting with high torque motors can reduce the number of stages needed, reducing cost, size, and losses. Hybrid servos based on indirect permanent magnet transverse motors can provide wide speed ranges at high efficiency, and minimize energy lost while holding loads while transporting.



On growing cost concerns in light of tariffs and escalating China trade war

- We do our design and fabrication — mechanics, cases, electronics assembly, final assembly — in the U.S. Some of our smaller motors are obtained from China, but these are a smaller portion of our total cost, and, at least for the first two rounds, most types have not been affected — though the third proposed round will end up picking up most of the remaining China sourced motors. The hybrid servo motors we generally use consume a much smaller quantity of magnetic material than conventional servo motors, limiting the price effects of these materials.

On value-added actuator solutions

- QCI has made (its) business from integrated motion control as well as remoted control boxes. Many of our applications are able to run direct drive due to the high continuous torque ratings produced by hybrid-servo motors and to their high torque constants and high motor quality factors $Kq = \text{Torque}/\sqrt{\text{power}}$. Software allows variable torque, variable speed, emulation of particle clutch, as well as many communications options and onboard programming through customer-friendly development environments. When a gearmotor is required, hybrid servos can typically reduce the number of stages due to the high motor torque available, as well as the high inertial mismatch capability of hybrid- servo motors.

On control integration as a key driver in the growth of brushless DC motors

- Integrated fault detection, precise motion profiles, gentle starting and four-quadrant control of the motion — simple-to-complex program capability — are all built into the motor package. This significantly reduces the integration effort, cabling volume, and costs. Total system performance is also well parameterized from the data sheets, and integration design is reduced.

Jack McGuinn

For more information

Don Labriola, president & founder
QuickSilver Controls Inc. (QCI)
990 N. Amelia Ave
San Dimas, CA 91773
Phone: (909) 599-6291
quicksilvercontrols.com

WIN THE FUTURE

Immerse yourself in the broadest range of automation solutions in North America and discover how automation can help you get ahead.



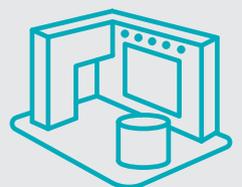
APRIL 08-11, 2019
McCormick Place | Chicago, IL

REGISTER TODAY AT
AutomateShow.com

Interested in exhibiting at Automate 2019?

Reach 20,000 potential customers by exhibiting at Automate! 85% of the attendees will recommend, specify or approve purchases of the technologies on display at the show.

Visit www.automateshow.com/for-exhibitors to learn more and reserve your space.



Aluminum Worm Speed Reducers

Our aluminum worm speed reducers provide improved performance, high reliability and easy maintenance.



- 7 sizes, 28-110 mm CD
- 12 ratios from 5:1 to 100:1
- Flexible coupling input
- Aluminum housings
- NEMA, IEC, or Servo Motor Adapters

DIEQUA
Corporation

diequa.com/pte 800-276-1294

Screw Jacks

The Zimm screw jack series offers all the connecting, drive and safety components from a single source.



Download the application guide today!

DIEQUA
Corporation

diequa.com/pte 800-804-8619

Engineering sMart

is your resource for the latest in great ideas from our advertisers. Check this section every issue for sMart Engineering ideas and technology.



For information about advertising, contact Dave Friedman at

(847) 437-6604

or

dave@powertransmission.com.



NORTH AMERICA'S JOB SHOP

Serving the Gear Industry Since 1963

RIVERSIDE
SPLINE & GEAR INC.

- ⚙️ Emergency Gear Replacement
- ⚙️ Complete Spur & Helical Gears & Pinions
1/2" (12mm) - 59" (1500mm)
- ⚙️ 2-4 Day Turnaround for Gear Grinding

810-765-8302 • 1390 South Parker, Marine City, MI 48039 Quotations to: rfq@splineandgear.com



- Industries Served:
- Mining
 - Oil & Gas
 - Machine Tool
 - Electrical
 - Steel
 - Paper
 - Mixing





B&R

MACHINE AND GEAR CORP

BRGEAR.COM


Nordex[®]
INCORPORATED

turnkey solutions with a higher level of intelligence

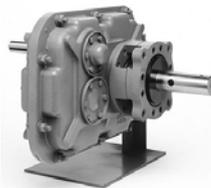
sales@nordex.com
eng@nordex.com
(203) 775-4877

**ISO Certified / ITAR
Registered / Trace Certified**

- Standard Components
- Made to Print Parts
- Design & Engineering
- Gears, Pulleys & Racks
- Assemblies



Nordex.com



YOUR FIRST & **LAST STOP** TO SHOPPING FOR A GEARBOX!

- Higher Ratios = Optimal Power Density
- Direct Coupled = Simplified Drive Package
- Front Mounted Tapered Bushings = Easy Install & Removal
- 25% Higher Mechanical Rating = Greater Service Margin
- Narrow Design = Lower Overhung Load On Bearing
- Double Lip Seals & Sealant Groove = Oil Leak Prevention
- 70% Higher Thermal Rating = No Fans or Expensive Lubricant

Dorris.
GEAR DRIVES

17430 Malyn Blvd. Fraser, MI 48026

www.DorrisCo.com

586-293-5260



Hannover Messe USA: What We Learned

Matthew Jaster, Senior Editor

IMTS 2018 had its fair share of machine tools, 3D printers and advanced robotics.

Meanwhile, the East Hall — home to Hannover Messe USA — took a more systematic approach, highlighting the smart components and techniques that will be integral in developing the digital factory of the future. Motion control, automation and mechatronics will each play a crucial role particularly as more and more industrial processes become digital. Here are some immediate takeaways from our time spent at Hannover Messe USA:

Industry Innovators are Leading the Way

Companies like Siemens and ABB (B&R Automation) are offering a variety of tools, controls and automation capabilities to improve areas in everything from material handling and packaging to milling gear generation and software.

Case in point: A Siemens booth tour highlighted how shop floor machines will be operated, managed, programmed and maintained in the future. The full process chain—from CAD to CAM to virtual simulation and onto production—gave visitors a sneak peek into life as an engineer in 15 to 20 years.

B&R Automation announced a new communication protocol during the show that will allow all production process data to be transferred using a single protocol. The X20BC008U bus controller functions as an OPC UA server and provides all information about connected I/O modules to OPC UA clients from any manufacturer. This includes, for example, controllers, SCADA systems, ERP systems or cloud applications. It essentially eliminates interfaces, gateways and the associated loss of information that occurred in the past.

A Systematic Endeavor

Mechanical, electrical and computer engineering (your basic mechatronics platform) continues to work its way into our industry. Companies are no longer looking at a single component or focusing on one product that they've been selling for years. Digital factory solutions require a systematic approach and companies like Lenze America are taking the lead in this area.

"We're looking at everything these days beyond just the components," said Ralph Rosa, president at Lenze America. "We have the electrical, the mechanical, the drive controlling the speed, the data available in the cloud. In between, we do motion control for the robotics and our PLCs handle the automation. Basically, a company that started in 1947 with geared motors has become a complete solutions provider. It's a pretty exciting time to be involved in these areas."

Complex Material Handling Systems

SEW Eurodrive displayed its mechatronic drive system including the Mov-iGear Series where motors, gear units and electronics come together to offer a simplified engineering solution. The MoviGear Series offers a high level of system efficiency, which in turn helps lower the energy costs. The integration and coordination of all the drive components leads to a long service life and high system availability. Shaun Millington, systems engineer, discussed how these intelligent devices reduce the startup time and support the monitoring and maintenance tasks. Drive tasks can be solved quickly and easily using corresponding application software.

The housing has been optimized specifically for these types of applications and can be easily integrated in today's conveyor systems. It also enables new developments to be implemented

from a completely new perspective. This technology masters high break-away and acceleration torque levels after longer system downtimes time without any limitations. The power required to drive the system can be reduced significantly.

There's a Solution for That

Igus is getting creative with its product offerings in 2018. The company recently introduced a low-cost, delta robot solution for automation needs. This delta robot includes a maintenance-free toothed belt drive, encoders, stepper motors and optional drive controllers. Chris Dennen at Igus believes the low price point and easy installation gives Igus a unique solution for assembly functions, pick and place tasks and inspection applications.

"The cost-effective delta robot enables our customers to have their own control box and integration at a cost of less than \$9,000," said Matt Mowry, Igus' U.S. drylin product manager. "They pay off after just a few months, a maximum of half a year."

Other interesting news from the Igus booth is how the company continues to find ways to tie its variety of products together to create new automation and shop floor solutions such as combining its cable and chain products with its linear guides to create customized solutions.

Real Time Monitoring

While we've reported plenty of information on bearing and motor monitoring practices in the PT industry, the trend for more sensors and more data collection is indeed expanding to all of the components found in the pages of *PTE*.

Bruce Gretz, executive vice president at Steinmeyer, discussed the monitoring of ball screws during the show. "Steinmeyer is utilizing sensors to detect the wear of critical machine

components in order to collect data to reduce downtime and optimize a maintenance plan,” Gretz said.

With these capabilities, Steinmeyer can detect component issues at an earlier stage and order the necessary maintenance in a timely fashion. The company is also working with IFM, a sensor specialist, to develop a system for the status monitoring of ball screws.

IMTS: By the Numbers

This record-breaking event — 129,415 trade show registrations, 2,563 exhibitors and 2,123 booths — proved that digital technology, automation and additive manufacturing are driving interest in manufacturing technology. You were hard-pressed to walk any of the McCormick Place Halls last week and not find SOLD signs on several machines or see smiles on the faces of sales personnel. The word is out that the technology available today will better prepare manufacturers to conduct business in the years to come.

According to Peter Eelman, vice president, exhibitions and business development at AMT, IMTS 2018 set records because “manufacturing technology has grown exponentially since the last show. The booming manufacturing economy means visitors have capital and are ready to invest.”

The Conversation Continues

Hannover Messe is driving forward the digital transformation of the production and energy industries. Every year marks the next step into the future. For 2019, the guiding theme is “Integrated Industry—Industrial Intelligence,” for the show in Germany where digital networking between humans and machines in the age of artificial intelligence will be examined. Read upcoming issues of PTE to learn more about the components and systems featured at Hannover Messe USA 2018. **PTE**



Igus had a low-cost, delta robot automation solution on display at Hannover Messe USA at IMTS 2018.

Step vs. Servo – Selecting the Best

Dan Jones

Over the many years, there have been many technical papers and articles about which motor is the best. The short and sweet answer is — let’s talk about the application. More recently a number of papers and articles have appeared that compared each motor’s advantages and disadvantages in generic or specific terms. Many times, the methods used to drive and control these motors are not completely described due to the many control schemes available for use. A few articles focus on just the open loop step motor and the closed loop servo motor advantages and disadvantages in a laundry list format. This article is attempting to “drill down” into the reasons why and to describe how it is done.

Basic Control Schemes

There are two major basic control schemes, open loop and closed loop. The open-loop control scheme has no feedback sensor. It utilizes the self-regulation capabilities of the motor (in this case the step motor). The closed-loop scheme feeds back speed, torque and position or any combination of these signals to a comparator that compares the measured sensor’s signal output to the command to create an error signal. The error signal is then electronically driven to zero as the servo approaches the final commanded position. A typical set of torque-speed plots is shown in Figure 1. I can illustrate the conventional open-loop step motor’s better performance at lower speeds versus the closed-loop servo at higher speeds. But other performance parameters are also important.

Encoders and resolvers are examples of special sensors or feedback devices that measure actual position and/or speed that helps to create the error signal.

Other components can play a major role in the motion system’s movement and positioning accuracy. But, before one reviews all elements in a position or servo system, let’s review the step and servo motors in more detail.

The Hybrid Step Motor

While there are a number of step motor types, the hybrid step motor is the predominant step motor used across a wide range of industrial, medical and automation applications. It possesses a 3-dimensional magnetic circuit with dual 50-tooth magnetic rotor cups, one on each end of the rotor structure (Figure 2). By today’s nomenclature, it is a transverse flux motor. The hybrid step motor geometry results in a 1.8 mechanical degree move or step when a single voltage pulse is administered to the step motor windings. Counting the pulses yields the step motor’s new position.

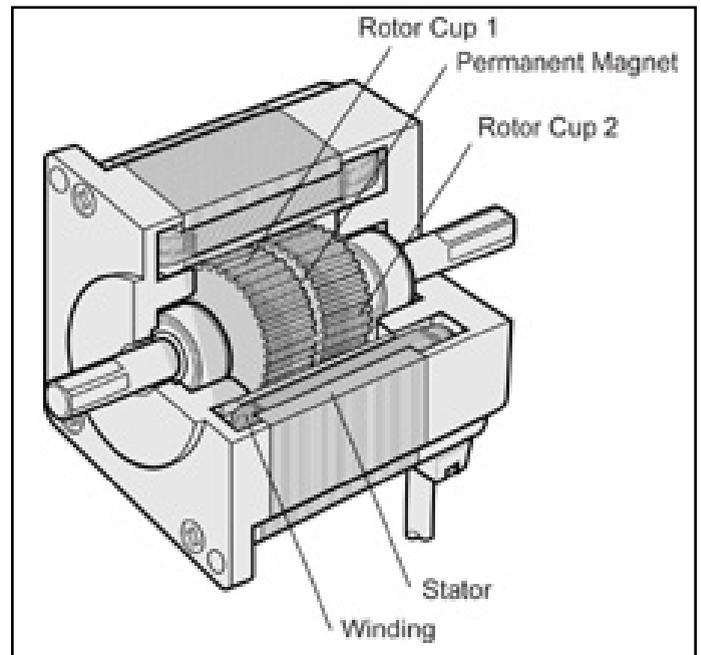


Figure 2 The hybrid step motor.

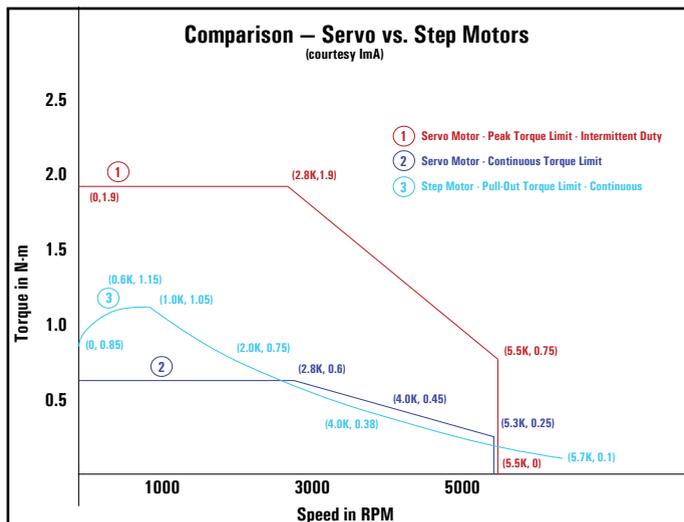


Figure 1 Comparison - Servo vs. Step Motors.

By definition, the motor is a synchronous, 2-phase, 50-pole brushless permanent magnet (PM) motor. It has a mechanical clearance or air gap of under 2 thousandths of an inch, the smallest of any popular motor type. There is no need for any sensors when operating in a successful open-loop control scheme. The step motor may oscillate and/or resonate around its final position before it settles down. Excessive oscillation could lead to loss of step.

Next in line in popularity is the 5-phase step motor. If the 2-phase hybrid step motor is given a 10 full step command, it will move 18 degrees with a position error of ± 0.05 degree unloaded. If the 2-phase step motor moves 10,000 steps, the step error is still ± 0.05 degrees. The step error is non-cumulative.

Oriental Motor, a leading supplier of 5-phase step motors, has developed it into an audibly quieter motor. While the rotor is the same for both 2- and 5-phase step motors, there

are 8 windings for the 2-phase motor and 10 windings for the 5-phase motor. The 5-phase step motor has a smaller resolution at 0.72 degrees per step (see Figure 3).

Both hybrid step motor types develop more torque than the equivalent sized servo motors below 1,200 full steps per second (about 350 to 400rpm). Other smaller 2-phase and 5-phase full step hybrid step motors are available; however, the 2-phase, 1.8 degree and the 5-phase, 0.72 degree hybrid step motor are the most popular types. The 5-phase hybrid step motor has the same step accuracy as the 2-phase step motor: $\pm 3\%$ position needs unloaded. The 5-phase step motor is more motion stable than its 2-phase counterpart. Because the 5-phase step motor moves only 0.72 degrees per step, it is nearly impossible for the 5-phase step motor to miss a step due to overshoot or undershoot motion. More will be covered in the drive section.

Driving & Controlling a Step Motor

Figure 4 shows an open-loop step motor system in block diagram form. The first block diagram is the computer or PLC, the brains of the system. It provides the indexer with the start

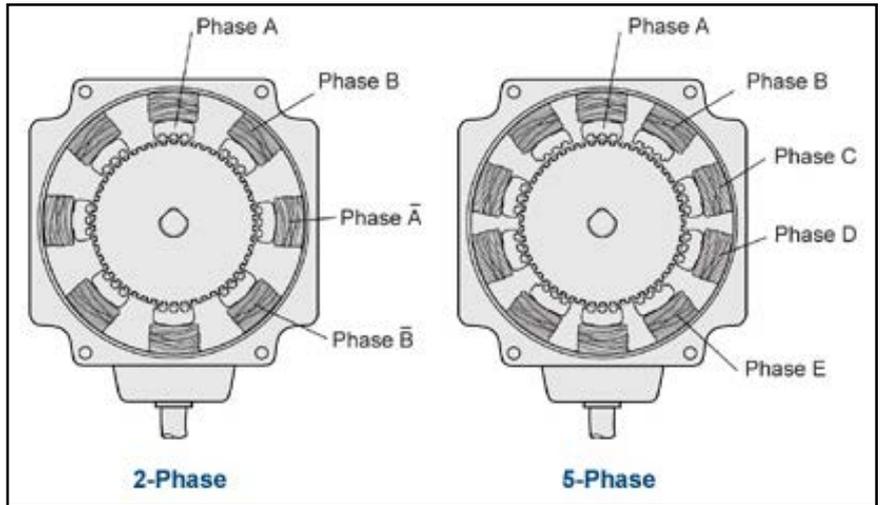


Figure 3 Cutaway view of 2-phase and 5-phase step motors (courtesy Oriental Motor).

operating command and the number of pulses that the steps it must move to achieve a required position. The indexer outputs the correct number of pulses and alters the pulse frequency to accelerate, run at a fixed slew speed and then decelerate the step motor and its associated machine load to the commanded position.

The next four system blocks comprise the electronic drive(r). The phase control takes the indexer pulses and

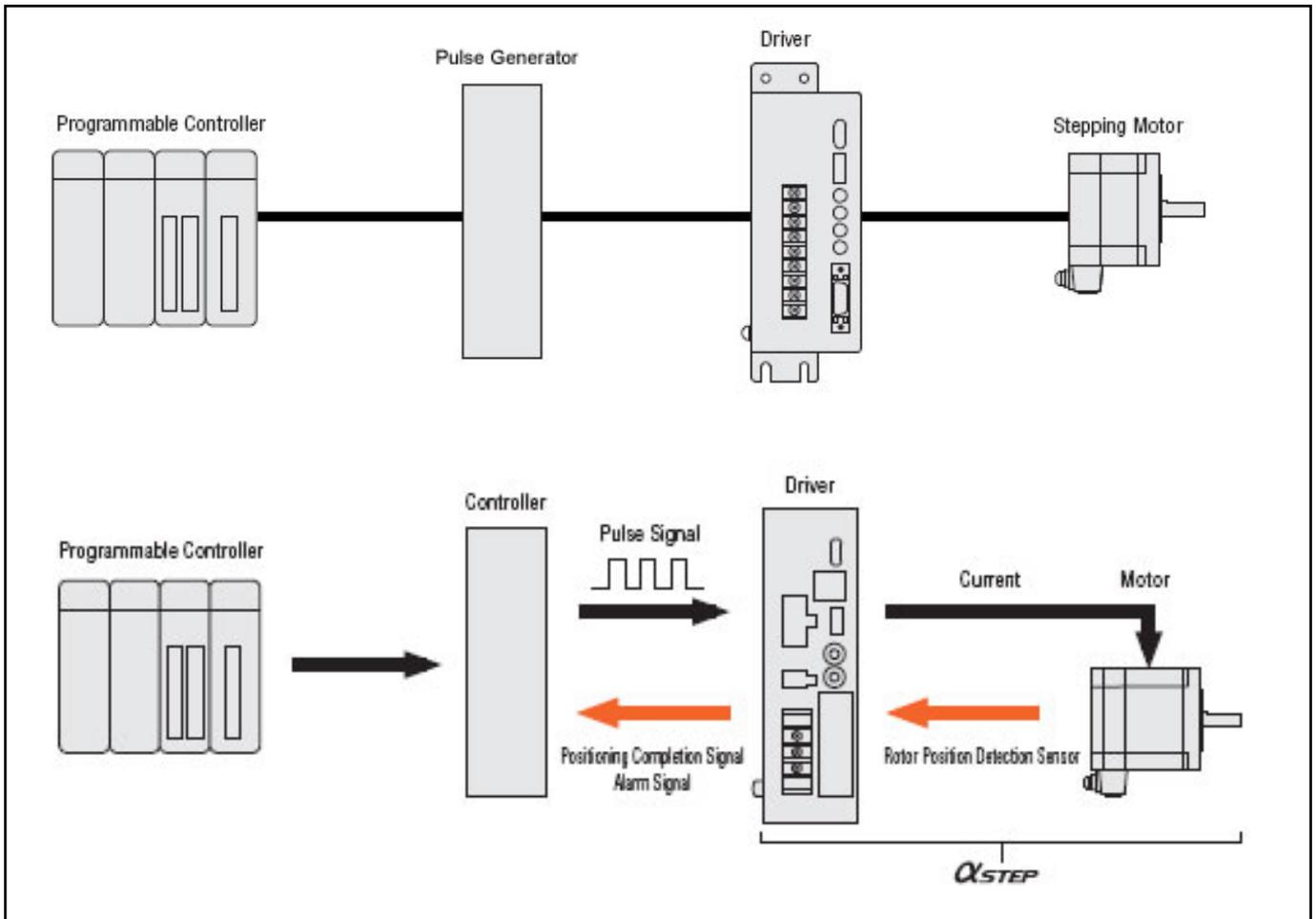


Figure 4 Open loop control of a step motor.

determines which phase or phases are energized in a sequential manner. It is here that any one of four drive sequences can be employed on the computer and indexer inputs. The smaller power supply energizes the various phase control ICs. The phase control logic furnishes the power amplifier with signals used to correctly energize the motor phases. The transistorized power amplifier supplies the higher current and voltage to the step motor from larger power device in order to move the motor and load.

As mentioned previously there are four basic ways to drive an open-loop step motor:

1. Wave Drive (one-phase energized — Full Step)
2. 2 phases on (traditional Full Step)
3. 1-2 phases on (Half Step)
4. Microstep (2-phase vector)

By far the most popular drive topology is the microstepping drive. Microstepping subdivides each full step into a family or series of 8 to 256 microsteps. The discrete full step-by-step motion can be quite spasmodic, particularly at lower speeds.

Microstepping is accomplished by employing pulse width modulation (PWM) to control current to the step motor windings. The driver sends two sine wave voltage waveforms phase shifted 90 degrees one from another. While current is increased in one winding, it is decreased in the other winding phase. The gradual increase in one and decrease in the other results in a much smoother motor current waveform that leads to a more stable run torque profile. However, both torque perturbations and speed ripple are still there but at greatly reduced waveform magnitude.

Now that all the important elements have been identified, how does the engineer combine them to create a successful open-loop step motor system? The starting point is to review the step motor's full step torque-speed (power) performance curve. Next use at least a 30–50% torque margin at the application's specified torque and speed points. Use the pullout torque values. The higher selected torque margin is necessary for load inertia changes and other application variations. Select a microstepping drive (if possible) to reduce resonances or vibrations. Remember, the hybrid step motor does not self-adjust its torque speed and current as the brush and brushless PM motors do. What changes is the developed torque. If the torque needs to rise above the step motor's pullout torque, the hybrid step motor will lose synchronism and

stall. If this happens one must select a larger motor size with more torque and begin the selection again or operate at a much lower speed or frequency. If cost is a major concern, then one must begin the selection process with a hybrid step motor drive using an open-loop drive topology.

Summarizing, the step motor drive system has the following advantages:

- Simpler open-loop drive
- Un-energized detent torque holds final position
- Lower system cost
- Higher shaft torque at lower speeds
- Microstepping smoothes velocity ripple

Disadvantages include:

- Position overshoot and ringing at final position
- Loss of steps while moving at high load or high speed
- limited to speeds below 1,200 rpm
- Lower power efficiency than servo motors
- Can create more internal heat than equivalent sized servos, particularly at higher speeds

The Servo Motor

The typical servo motor is a brushless PM motor with magnets located on the moving rotor. The magnets can be on the rotor hub outside diameter (OD) or buried inside the magnetic rotor hub structure (see Figure 5). The number of magnets in an industrial servo motor can vary from 6 poles to 120-plus poles.

A brushless servo motor is designed to maximize peak torque and fast acceleration capability. The smaller brushless PM servo motors use the NEMA frame sizes (i.e. 17, 23, 34 and 42) as do the hybrid step motors.

The term “servo motor” is not technically correct. The motor by itself has some crude back-EMF signals that can help control speed variations. However, the motor cannot position itself without a set of separate stator coils or an internal resolver or external encoder to provide the needed

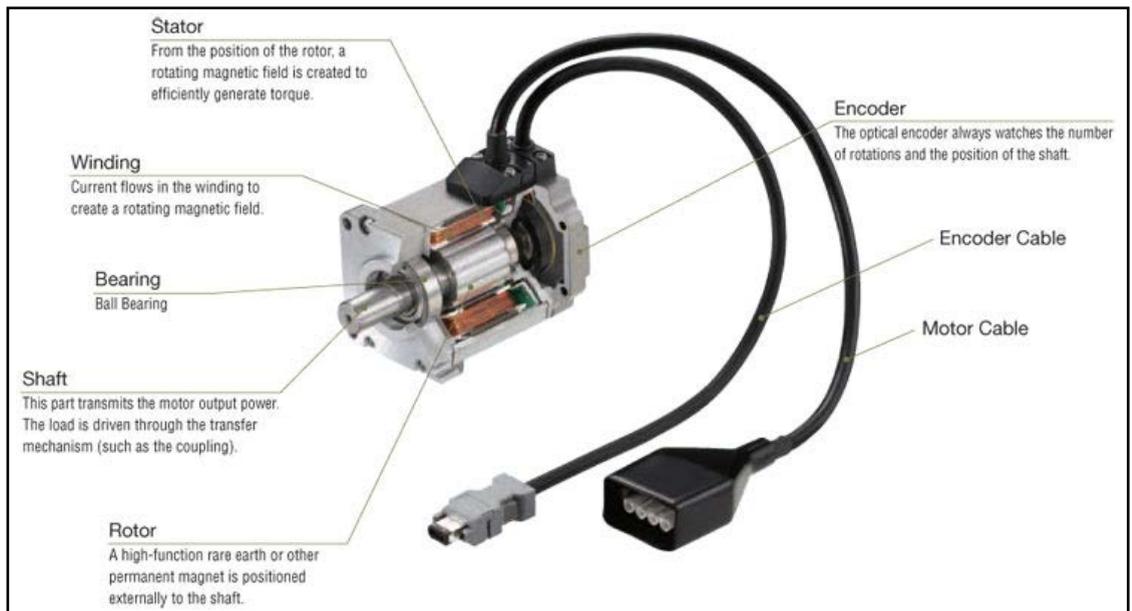


Figure 5 Servo motor construction.

position accuracy for today's 12- to 24-bit encoder position resolution and accuracy used in industrial and factory automation equipment.

The conventional brushless PM motor requires a separate encoder or resolver to provide the necessary feedback sensor signals to control torque, speed and positioning accuracies for servo operation. These extra components increase the overall servo price when compared to the open-loop hybrid step motor. One must use various sensor feedback signals to better stabilize and control the servo motor's motion and positioning requirements. A closed-loop servo control scheme can perform this task better than an open-loop scheme. Any synchronous motor can utilize a servo control scheme. This includes switched reluctance, brush and brushless PM motor and even the hybrid step motor.

Driving & Controlling a Servo Motor

A servo control harnesses several feedback device signals to create a closed-loop or servo control system condition. Position, speed, current/torque are typical closed-loop feedback signals used to develop position, speed and current measurements "on the fly" from the encoder or resolver to be compared to the various command signals. The difference between commanded signals and measured signals creates the analog error signals used to drive and control servo motion to a zero error and its final commanded position. Figure 6 reveals a device diagram at the top and a block diagram below for an analog servo system. The programmable controller (computer or PLC) inputs a series of command signals to the motion controller that also receives the processed feedback signals to create the servo error signals. Potentiometers are used for adjusting the feedback loop gains.

The combination of a 3-phase brushless PM motor, an encoder or resolver with the aforementioned electronic controller provides the following:

- Performance Advantages:
- High Torque to Inertia (peak torque)

- Superior position resolution (encoder)
- No major resolution or vibration issues
- Higher shaft speeds
- Lower motor internal losses
- Higher load efficiencies
- Higher power density
- Lower position overshoot
- Wider range of motor frame sizes

Disadvantages include:

- Higher cost
- More complex circuitry
- Tuning feedback gains more complicated
- Feedback gains susceptible to drift (analog servo)
- Can accumulate servo errors

An excellent example is Oriental Motor's NX family of brushless PM motors with a number of servo controls. A high-performance, 20-bit optical encoder is mounted on the motor for carrying out highly accurate positioning operations. A separate reference or home position is used to periodically erase the accumulated servo errors. The NX family is composed of several NEMA frame sizes with continuous power levels covering 50 watts to 750 watts. A tuning algorithm for many application load inertias is used to establish the potentiometer gain settings for each feedback loop. Figure 7 establishes the torque vs. speed performance curve for a 200 watt NEMA size 24 brushless PM motor.

Digital servos are gaining in popularity because they produce a faster response times, simpler ease of auto-tuning and tuning the loop gains. The various loop gains are converted from analog to digital (A to D) signals. All the main control functions are carried out by the microprocessor solving a series of motion equations. Included in its programming is a mathematical model of the servo system that predicts the system's motion behavior.

One of many control strategies is to utilize a PID controller. It can continuously compute the servo error and compensate by varying the

Proportional, Integral and Derivative circuit gains. While PID control remains the most popular digital control scheme, there are some others in use depending on the application requirements.

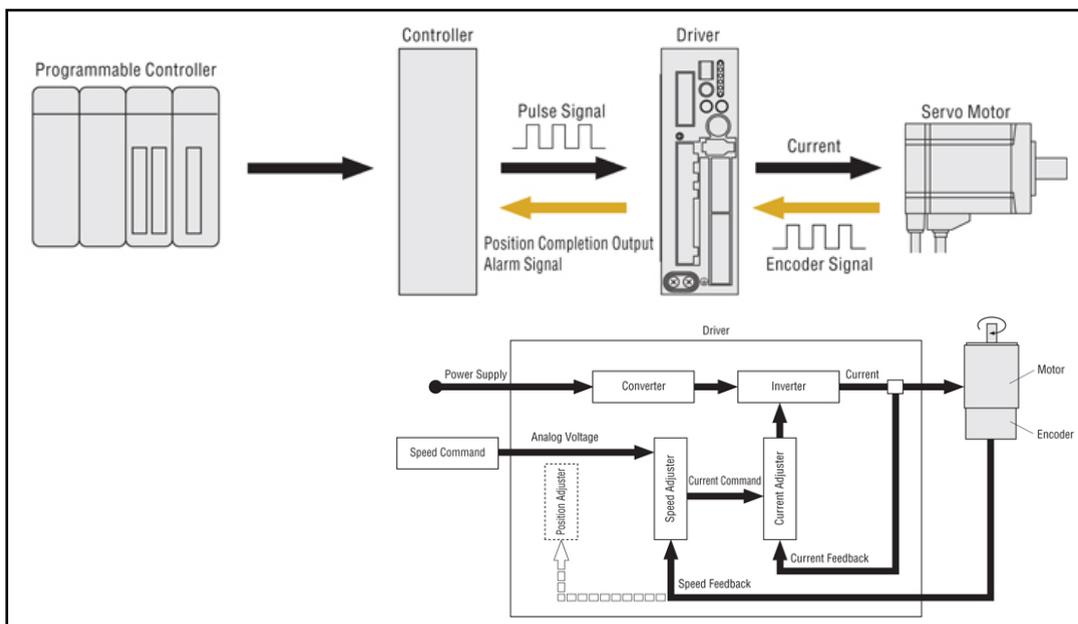


Figure 6 Driving and controlling a servo motor.

Know the Application Needs

Now that the more popular electric motors (step vs. brushless servo) along with their associated drives and controls have been reviewed, the application engineer must develop a profile describing his application needs. The application needs must be matched to the motor's capabilities along with the supporting drive and system requirements.

Sizing

Sizing or selecting a step motor or servo motor requires some mathematical calculations. Most motor manufacturers have developed a computer-based selection program to assist the prospective customer in sizing the application to one of their motors. One selects the servo that best matches the application requirements.

The Oriental Motor Technical Reference supplies the formulas for computing inertia and torque as well as the formulas for selecting the proper step or servo motor. Examples for both step and servo motor selection are liberally included.

It begins with sizing the motor for available space and the motion profile needs. The initial sizing process covers both step and servo motors. Determine what the motion profile looks like. From this profile one can determine the acceleration (and deceleration) requirements. The needed motor speeds can be obtained for repetitive operation. The variable non-repetitive operations require the application engineer to calculate the peak speed and torque and then focus on the motion time.

The available input voltage is set at specific voltages: 120 VAC, 240 VAC rectified to 160 VDC, 320 VDC rectified for all motors typically over 3.35 inches in outside diameter. Smaller sized motors use DC power supplies at 24 VDC, 48 VDC, 72 VDC, 80 VDC and other voltages.

Torque in the form of peak torque for servo motors and pullout torque for step motors is determined by computations using the various formulas found on the internet. One must account for the application mechanism's friction and inertia to establish the total torque during acceleration, slewing and deceleration motion. For example, multiply the acceleration by the total inertia (load + motor) and the results are then tabulated. The list typically includes the supply voltage, rated speed, continuous torque, peak torque and motor size.

The next operation is to tentatively select the motor and confirm its performance vs. application requirements match. For open-loop step motors, apply the needed torque margins, convert the pulses or steps per second into rpm and verify that the selected step motor will more than match the application requirements. The computations for inertia and torque are the same for step motors.

Gathering the various needed performance parameters for both step and servo motor systems will allow the equipment supplier to utilize the various motion companies' selection programs. It will gain some insight into the engineer's application performance requirements. The program can be utilized substituting new performance parameters or contact the motor and drive supplier's application engineer for assistance. This action is the beginning of the road to success. **PTE**



Speed – Torque Characteristics

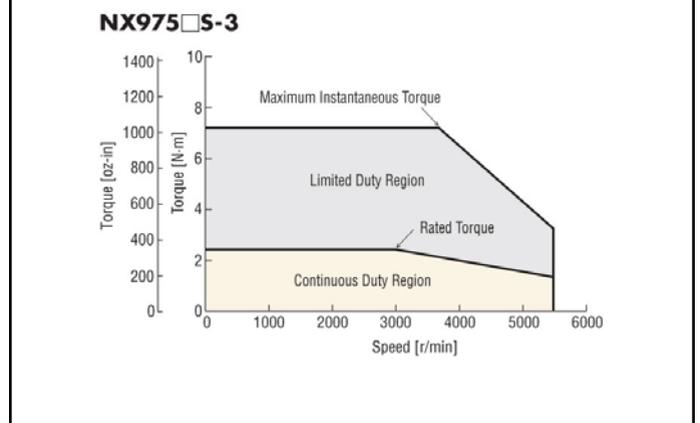


Figure 7 Torque vs. speed performance curve for a 200 watt NEMA size 24 brushless PM motor.

Acknowledgement

The author would like to acknowledge the help supplied to him by the Oriental Motor Engineering Department concerning data and the illustrations for this article.

Dan Jones received his BSEE degree from Hofstra University in 1965 and MS in Mathematics at Adelphi in 1969. He has over 50 years' experience in the design of all types of electric motors and generators from 10W to 500 kW and has held engineering design, management and marketing management positions at a number of companies. He is recognized as an international authority on electric motors and motion control. He has written 250+ technical articles/papers and held seminars in 10 countries. He is a past member of the board of directors of SMMA and EMERF. In 2014 he received the EMERF Lifetime Achievement Award for "Outstanding Contributions to the Electric Machines Industry." He is a life member of IEEE and a member of ASME.



Hungry for More?



Everything you need if you buy gears, bearings, motors, couplings and clutches.

Power Transmission Engineering

- Product and Industry News Updated Daily
- Directory of Mechanical Power Transmission Suppliers
- Exclusive online content in our e-mail newsletters
- Back Issues and Article Archive
- Calendar of Upcoming Events for power transmission professionals

FREE SUBSCRIPTION!

www.powertransmission.com

Smashing the Efficiency Barrier — A Practical Comparison of Planetary and Orbitless Gear-Heads

Leo J. Stocco and Robert Gloeckner

Introduction

An Orbitless (patent pending) gear-head is a novel fixed-ratio epicyclic gear-head with crank-shaft planet pinions and two carriers, but no ring gear. It provides half the reduction ratio of a planetary gear-head with similar pinions and shares many characteristics such as torque splitting and co-axial drive shafts that spin in a common direction. Three prototype Orbitless gear-heads are constructed, each with a different planet support mechanism. It is shown that load capacity is marginally improved by using ball instead of plain bearings, and greatly improved by mounting the bearings to the planets rather than the carriers. In comparison to an off-the-shelf planetary gear-head, friction losses are reduced by up to 59% and total input power is reduced by up to 33% over the operating range of the motor and gear-head.

Fixed ratio speed reducers may be broadly classified as high or low-ratio, depending on whether they provide a ratio that is above or below approximately 10:1 (Ref. 1). High-ratio designs are numerous and include the worm, cycloid, orbit, nutating, harmonic (Ref. 4), stepped-planet (Ref. 3) and bi-coupled planetary gear-heads. Each is

arguably an implementation of one of two fundamental low-ratio gear-head configurations—the offset and planetary—both of which are literally thousands of years old.

In (Refs. 7-8), the Orbitless gear-head is proposed, which is a third low-ratio configuration that shares various advantages with offset and planetary gear-heads. Like an offset gear-head, it may be made entirely from pinions and does not experience reverse bending. Like a planetary gear-head, it has load sharing, sequential meshing, in-line drive axes (optional) and a common drive direction. However, it has a lower pitch line velocity which is shown to improve efficiency, and a lower planet bearing velocity, which extends the computed bearing life.

In this paper, the Orbitless gear-head properties are summarized. Three prototype gear-heads are constructed using off-the-shelf components. Load capacity, speed, and efficiency are measured in a series of destructive tests, and the results are compared to a commercial planetary gear-head. It is shown that the Orbitless prototype has a comparable load capacity and significantly higher efficiency than the planetary gear-head.

Anatomy of an Orbitless Gear-Head

An Orbitless gear-head resembles a planetary gear-head in that a high-speed (input) shaft drives a sun pinion which is surrounded by a collection of planet pinions that ride on an output carrier which drives a low-speed (output) shaft (Fig. 1). Instead of an orbit (ring) gear, an Orbitless gear-head includes a second reaction carrier which engages each planet on a second planet axis. Although the two planet axes must not coincide, they may otherwise reside anywhere. Orbitless planets do not rotate. They circulate the sun at a fixed orientation so neither planet axis must intersect the planet center.

In Figure 1, two versions are shown. The in-line version on the left has its drive carrier planet axes intersecting the center of each planet which results in co-axial input (high-speed) and output (low-speed) shafts. The offset version on the right has symmetrically offset planet axes which accommodates larger planet bearings for longer bearing life but has an offset between the input and output shafts that is equal to the drive carrier planet axis offset. The reduction ratio i , planet bearing velocity ω_p , and pitch line velocity plv of a

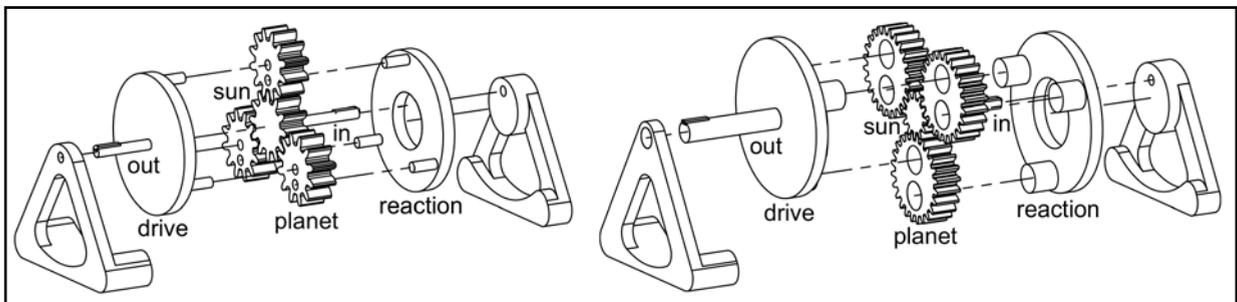


Figure 1 In-line and offset shaft Orbitless gear-head.

This paper was first presented at the International VDI Conference on Gears 2017, Garching/Munich [VDI-Berichte 2294, 2017, VDI Verlag GmbH] and is reprinted here with VDI approval.

planetary and Orbitless gear-head are derived (Ref. 9) and shown in equations (1-6), where s and p are the numbers of teeth on the sun and planet, ω_s is the angular velocity of the sun (high-speed shaft) and M is the tooth module.

Planetary

$$i = 2 \left(1 + \frac{p}{s} \right) \quad (1)$$

$$\omega_p = \frac{2(1-i)}{i(i-2)} \omega_s \quad (2)$$

$$plv = \frac{sM}{2} \left(\frac{s+2p}{2(s+p)} \right) \omega_s \quad (3)$$

Orbitless

$$i = 1 + \frac{p}{s} \quad (4)$$

$$\omega_p = \frac{-1}{i} \omega_s \quad (5)$$

$$plv = \frac{sM}{2} \left(\frac{p}{s+p} \right) \omega_s \quad (6)$$

Prototype Orbitless Gear-Head Design

A prototype offset Orbitless gear-head is constructed using OTS pinions from a Faulhaber Series 20/1 planetary gear-head with a 27-tooth sun; three 27-tooth planets; a module of $M=0.22$; and a ratio of $i=2:1$. It has 1mm OD planet journals—each spaced 1.1mm from the planet center—resulting in a 1.1mm offset between the high-speed (sun) and low-speed (carrier) shafts. Uniform 27-tooth sun and planet pinions do not provide sequential meshing or tooth hunting, but satisfy an availability constraint. The baseline for comparison is a commercial 20/1 planetary gear-head with a 21-tooth sun; three 18-tooth planets; a module of $M=0.22$; a ratio of $i=3.71:1$; a speed rating of 5,000 rpm; and a stall torque of 500 mNm (Ref. 7).

Planet bearings are typically the most stressed members in an epicyclic gear-head and are often the first to fail. Since Orbitless planets are supported by two bearings, space constraints limit bearing size—which raises durability concerns. To best address this design challenge, the three different Orbitless planet supports (V1-V3) (Figs. 2-3) are constructed, evaluated and compared.

In V1, the journals are interference fit into the planets and the bushings (plain

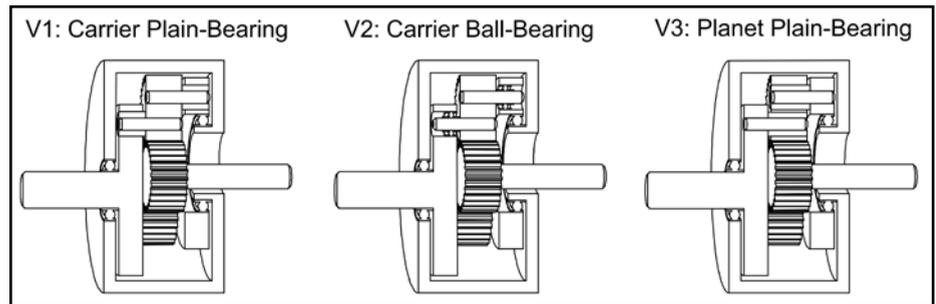


Figure 2 Orbitless planet support versions.



Figure 3 Versions 1, 2 & 3 Orbitless prototype gear-head.

bearings) are interference fit into the carriers. In V2, single-row, deep-groove ball-bearings replace the carrier bushings of V1. In V3, journals are interference fit into the carriers and bushings are interference fit into the planets. The L_{10} bearing life is calculated using the equations (Ref. 2) for an Orbitless gear-head with an input torque $\tau_{HS}=17$ mNm, $s=27$, $M=0.22$, pressure angle $\phi=20^\circ$, $N=3$. The bearing speed is $\omega_p=2,500$ rpm when $\omega_s=5,000$ rpm (Eq. 5). Using 1x3x1 GRW deep-groove radial ball-bearings with a load rating of $C=82$ N, $L_{10}=47,418$ hours, or 5.4 years, for the drive carrier and $L_{10}=64,023$ hours, or 7.3 years, for the

reaction carrier. This is well in excess of the 1 year rule-of-thumb for acceptable bearing life.

Test Fixture and Destructive Test Sequence

To evaluate load capacity, efficiency and speed rating, each gear-head is mounted to a Faulhaber 24V, 68W Series 2057-S-024-B 2-pole brushless DC-servomotor. The motor has a maximum speed of 55,000 rpm, a stall torque of 155 mNm and a maximum recommended continuous torque of 17 mNm at 5,000 rpm (Ref. 5). The motor is driven by a Faulhaber SC-2804 PWM speed controller (Ref. 6) and is

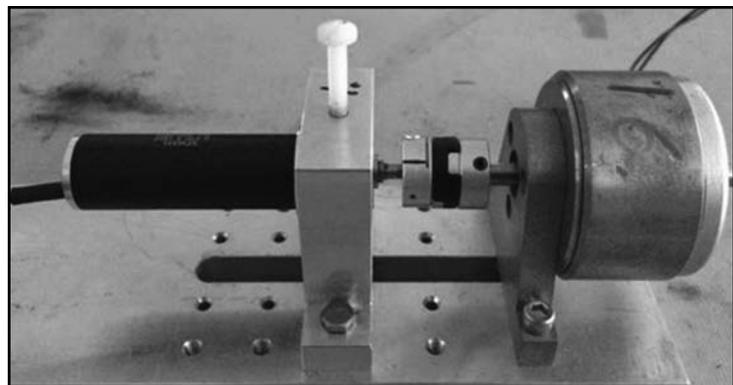


Figure 4 Test fixture for Orbitless vs. planetary evaluation.

controlled using Faulhaber *Motion Manager 6* software. The gear-motor is mounted in an aluminum fixture and is connected to a Magtrol HB-32-3 electromagnetic hysteresis brake using an Oldham coupling. The speed controller and brake are each powered by a Gold-Star GP4303A power supply. The same lubrication is used in all gear-heads, and all tools and test equipment have up-to-date calibration. The test fixture is shown (Fig. 4).

The applied load torque τ_{LS} is set such that the applied motor torque τ_{HS} consistent. It is computed based on an estimated 88% planetary gear-head efficiency and 95% Orbitless gear-head efficiency. The hysteresis brake current is adjusted until the desired output torque is recorded using a Honeywell model 651C-1 and 651C-2 torque

watch. Due to its higher estimated efficiency, the Orbitless gear-head delivers approximately 8% more output power to the load during each test phase.

The test parameters are specified (Table 1) where ω_{HS} , ω_{LS} , τ_{HS} and τ_{LS} are the angular velocity and torque of the high-speed input and low-speed output shafts respectively, and P_{OUT} is the power dissipated by the load. Each phase is run for 24 hours and the test is concluded once any abnormal behavior is detected, such as a change in sound or a substantial increase in current draw. The gear-heads are inspected periodically between phases to identify the onset of lubricant or mechanical failure. Phase 1 is a break-in period at no-load, Phase 2 is at the rated speed of the 20/1 gear-head, and Phase 3 is at 2x the rated speed. In phases 2 and 3, the

load is increased incrementally until the motor torque reaches its maximum-rated continuous torque (17 mNm uncooled) (Ref.5) and in phase 4 the speed is increased incrementally while the motor torque is held at 17 mNm.

Gear-Head Failure Modes and Probable Causes

The destructive test sequence described in Table 1 is conducted for the 20/1 planetary gear-head and each Orbitless gear-head version. Upon failure, each gear-head is disassembled, inspected, and the symptoms are documented. The onset of failure is detected with the planetary gear-head during Phase 4a at 12,000 rpm, which is expected after applying a reasonable safety margin to its 5,000 rpm manufacturer-specified speed rating. In Table 2, the test phase when failure occurred, the failure mode and the post-failure observations are tabulated for all gear-heads.

A post-failure inspection of the Version 1 Orbitless gear-head shows wear patterns on the journals where they align with the lateral faces of the bushings. The clockwise tooth face of the V1 sun gear is also visibly worn. Wear patterns on the carrier faces suggest that the planets contacted the carriers as a result of the conical bushing wear that was also observed. A post-failure inspection of the Version 2 Orbitless gear-head shows spalling and separation of the carrier mounted ball bearings.

The pre-mature bearing failures of Versions 1 and 2 are attributed to the planet bearings being mounted to the carriers. Since the applied bearing forces are lateral to tooth force, a yaw torque develops on the planets which causes bushing, tooth and lubricant wear in V1, and outright bearing failure in V2. This is illustrated (Fig. 5) where the upper planet axis engages the drive carrier and the lower planet axis engages the reaction carrier.

The ball-bearings are more robust to yaw torque and increase the load capacity of V2 over V1 by approximately 40%. Mounting the bushings in the planets in V3 vertically aligns all forces, eliminates planet yaw torque, and increases load capacity to a level comparable with the planetary gear-head. It is proposed that

Table 1 Test sequence of planetary and Orbitless gear-heads

Phase		ω_{HS} RPM	T_{HS} mNm	Planetary (88%)			Orbitless (95%)		
				ω_{LS} RPM	τ_{LS} mNm	P_{OUT} W	ω_{LS} RPM	τ_{LS} mNm	P_{OUT} W
1	a	5,000	0	1,348	0	0	2,500	0	0
	b	10,000	0	2,695	0	0	5,000	0	0
	a	5,000	4	1,348	13.1	1.8	2,500	7.6	2.0
	b	5,000	10	1,348	32.6	4.6	2,500	19.0	5.0
	c	5,000	17	1,348	55.5	7.8	2,500	32.3	8.5
3	a	10,000	4	2,695	13.1	3.7	5,000	7.6	4.0
	b	10,000	10	2,695	32.6	9.2	5,000	19.0	9.9
	c	10,000	12	2,695	39.2	11.1	5,000	22.8	11.9
	d	10,000	14	2,695	45.7	12.9	5,000	26.6	13.9
	e	10,000	16	2,695	52.2	14.7	5,000	30.4	15.9
	f	10,000	17	2,695	55.5	15.7	5,000	32.3	16.9
4	a	12,000	17	3,235	55.5	18.8	6,000	32.3	20.3
	b	14,000	17	3,774	55.5	21.9	7,000	32.3	23.7
	c	16,000	17	4,313	55.5	25.1	8,000	32.3	27.1

Table 2 Test phases and failure modes for each gear-head

Gear-Head	Phase	Failure Mode & Observations
Planetary 20/1	4a	<p>Change in sound</p> <ul style="list-style-type: none"> • Gear teeth in good condition • Planet journals in good condition • Planet bearings in good condition • Lubricant showing signs of degradation (separation)
Orbitless V1	3b	<p>Change in sound & large increase in current draw</p> <ul style="list-style-type: none"> • Gear teeth show serious non-uniform wear • Planet journals seriously worn near lateral bearing face • Planet bearings seriously worn in conical pattern • Lubricant burnt and solidified • Wear patterns indicating contact between lateral planet and lateral carrier faces
Orbitless V2	3d	<p>Seizure</p> <ul style="list-style-type: none"> • Gear teeth in good condition • Planet journals in good condition • Planet bearing failure (spalling & separation) • Lubricant in good condition
Orbitless V3	4a	<p>Change in sound</p> <ul style="list-style-type: none"> • Gear teeth in good condition • Planet journals in good condition • Planet bearings in good condition • Lubricant showing signs of degradation (separation)

load capacity may be further increased by mounting ball-bearings in the planets although space constraints may require a higher reduction ratio since that would introduce larger planet pinions.

The failure mode of the V3 Orbitless gear-head parallels that of the planetary gear-head. In both cases the test was stopped due to a change in sound quality, but no post-failure physical damage or wear was identified other than the initial signs of lubricant separation. In both cases the gear-head remains operational.

Efficiency Measurements

Efficiency values are derived by intermittently recording the current drawn by the motor IM during each 24 hours test cycle and computing the average. The total power input to the system P_{IN} is separated into electrical losses P_{ELEC} , mechanical losses P_{MECH} , and power delivered to the load P_{OUT} , as shown (Eq. 7). Electrical power losses are separated into impedance losses associated with the controller P_C and motor windings P_W , and mechanical power losses are separated into friction losses associated with the motor P_M and gear-head P_G , as shown (Eq. 8).

$$P_{IN} = P_{ELEC} + P_{MECH} + P_{OUT} \quad (7)$$

$$P_{IN} = (P_C + P_W) + (P_M + P_G) + P_{OUT} \quad (8)$$

Load power P_{OUT} is taken from Table 1. Motor friction losses P_M are computed (Eq. 9) where C_M is the manufacturer-specified (Ref. 5) motor friction constant in (mNm/rpm), and gear-head losses P_G are computed (Eq. 10) by subtracting the motor friction losses P_M and load power P_{OUT} from the total mechanical power produced by the motor windings.

In Equation 10, K_M is the manufacturer-specified (Ref. 5) motor torque constant in (mNm/A), I_M is the measured motor winding current, ω_{HS} is the motor speed, and the product $K_M I_M \omega_{HS}$ is the total mechanical power produced by the motor windings.

$$P_M = C_M \omega_{HS}^2 \quad (9)$$

$$P_G = K_M I_M \omega_{HS} - P_M - P_{OUT} \quad (10)$$

Motor winding losses P_W are computed (Eq. 11) where R_M is the

$$P_W = I_M^2 R_M \quad (11)$$

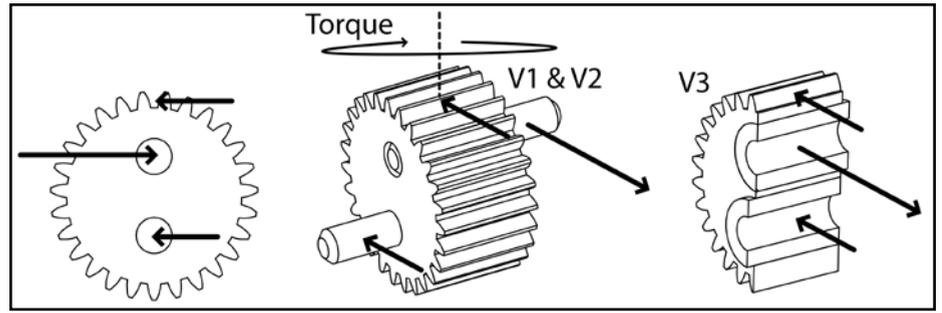


Figure 5 Orbitless planet forces and induced yaw torque.

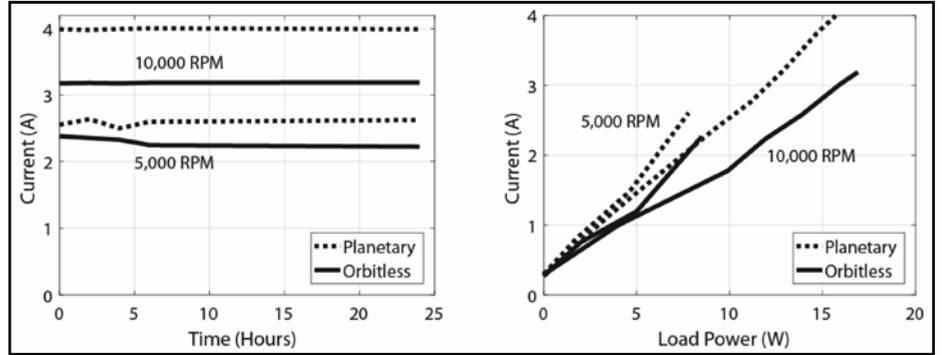


Figure 6 Raw (left) and mean (right) current measurements

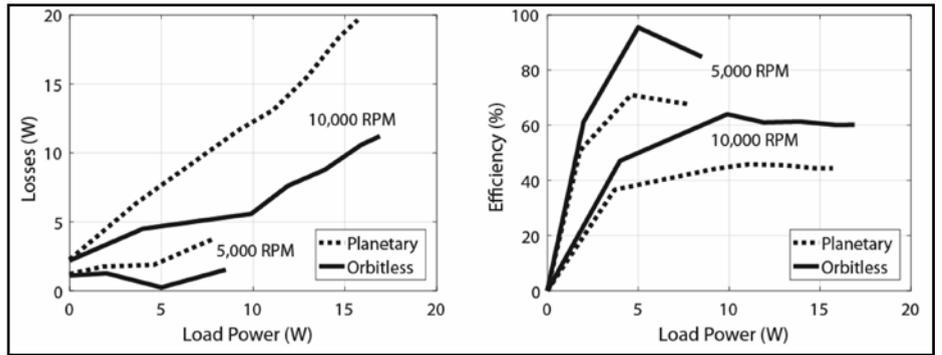


Figure 7 Gear-head power losses and efficiency.

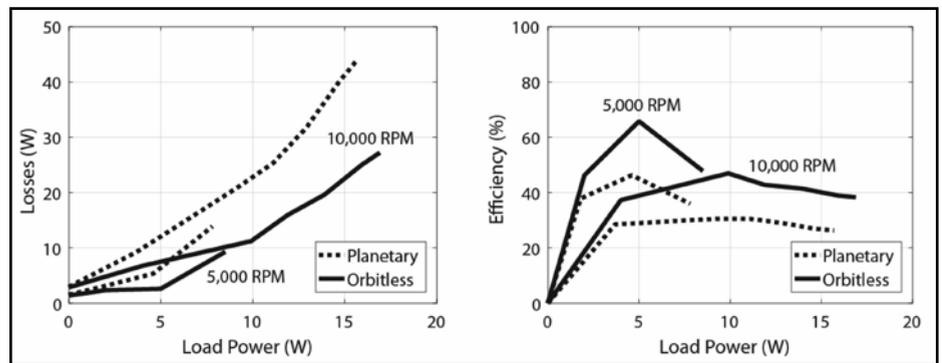


Figure 8 Total system power losses and efficiency.

manufacturer-specified (Ref. 5) winding resistance in (Ω). Controller losses P_C are computed (Eq. 12) where $P_W + P_{MECH} + P_{OUT}$ is the total power delivered by the controller and η_c is the manufacturer-specified (Ref. 6) controller efficiency in (%).

$$P_C = (P_W + P_{MECH} + P_{OUT}) \frac{100\% - \eta_c}{\eta_c} \quad (12)$$

Equations 7-12 are used to derive gear-head efficiency η_G (Eq. 13) and total system efficiency η_{SYS} (Eq. 14).

$$\eta_G = \frac{P_{OUT}}{P_G + P_{OUT}} \quad (13)$$

$$\eta_{sys} = \frac{P_{OUT}}{P_{IN}} \quad (14)$$

Examples of raw current measurements for Phases 2c and 3f for the planetary 20/1 and Orbitless V3 gear-heads are shown (Fig. 6). The mean value over the entire 24 hour period is also computed and shown for each successfully completed phase.

For each mean current, the individual power components are computed from equations (7–12), and gear-head and total system efficiency are computed from Equations 13–14 and plotted (Figs. 7 and 8).

The largest recorded improvement occurs at 5 W and 5,000 rpm where the planetary 20/1 gear-head demonstrates efficiencies of $\eta_G=71\%$ (gear-head) and $\eta_S=46\%$ (system), and the Orbitless V3 gear-head demonstrates efficiencies of $\eta_G=95\%$ (gear-head) and $\eta_S=66\%$ (system). This corresponds to relative improvements of 24% and 20%, respectively.

The power losses of all three Orbitless versions are superimposed (Fig. 9). The strong correlation suggests that the measured losses are intrinsic to the gear-head design and are largely independent of planet bearings. Losses do not deviate significantly when ball or

sintered bearings are used, or when bearings become worn and approach failure. This further supports the claim that bearing friction does not significantly impact efficiency.

In Figure 9, the gear-head and total system efficiency of the planetary 20/1 and Orbitless V3 gear-heads are also plotted against input speed ω_{HS} , at the maximum-delivered output power P_{OUT} , which corresponds to an approximate motor torque of 17 mNm in all cases. Both the gear-head and system efficiency are substantially higher at all speeds with an Orbitless gear-head, and the associated efficiency gain increases with input speed. The reduced pitch and bearing velocities are likely responsible for these apparently superior high-speed characteristics.

Conclusion

Mounting the planet bearings to the carriers induces a planet yaw torque that reduces the load capacity of an Orbitless gear-head. Mounting them to the planets avoids this yaw torque and results in an input load capacity that rivals a planetary gear-head while delivering approximately 8% more output power due to superior efficiency. Although planet bearing size is constrained by planets which must ac-

commodate two non-coaxial bearings, a low rotation rate extends bearing life which is computed to be in excess of 5 years for the example gear-head described here.

An experimental comparison between a prototype Orbitless gear-head and an off-the-shelf planetary gear-head demonstrates dramatic improvements in power consumption due to reduced pitch velocity and fewer gear meshes. When operated at full torque with a load that ranges from 8-20W, the following loss reductions are recorded.

- Gear-head losses: 43%–59%
- Motor winding losses: 24%–45%
- Total system losses: 33%–46%

In addition, total input power, including power delivered to the load, is reduced by up to 33%. For a battery operated system, this means an increase in run time of up to 49%. **PTE**

References

1. Jelaska, D. *Gears and Gear Drives*, Wiley, 2012.
2. Lynwander, P. "Gear Drive Systems Design and Application," Marcel Dekker Inc., 1983.
3. Muller, H.W. *Epicyclic Drive Trains*, Wayne State Univ. Press, 1982.
4. Musser, C.W. "Strain Wave Gearing," U.S. Patent #2,906,143, 1959.
5. www.micromo.com/products/brushless-dc-motors/brushless-dc-servomotors.
6. www.micromo.com/products/drive-electronics/drive-electronics-datasheets.
7. www.micromo.com/products/precision-gearheads/precision-gearheads-datasheets.
8. Stocco, L.J. Orbitless Gearbox, Patent Cooperation Treaty, CT/CA2015/050423, 2014.
9. Stocco, L. Orbitless Drive, ASME International Mechanical Engineering Congress & Exposition, Nov. 2016.

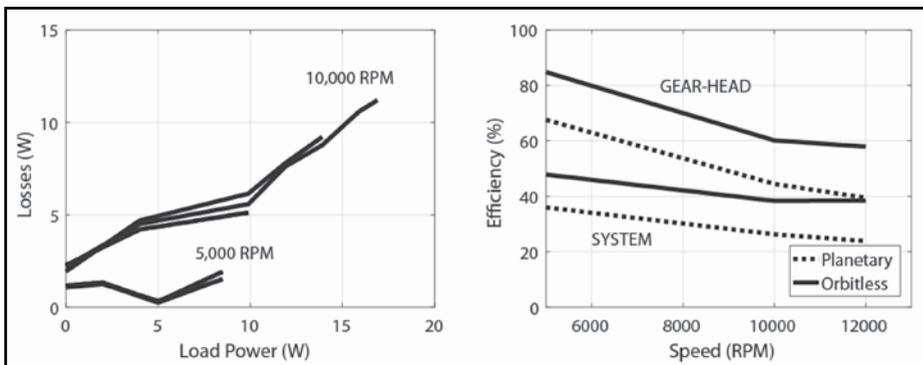


Figure 9 Orbitless gear-head losses and total system efficiency.

Leo Stocco is the CTO of Orbitless Drives and the inventor of the Orbitless drive technology. He is a professor in Electrical Engineering at the University of British Columbia where he specializes in electro-mechanical design and medical instrumentation. He obtained his Ph.D. from UBC in the field of mechanical robot optimization and spent five years as the director of robotics at Integrated Surgical Systems in Davis California.



Robert Gloeckner, R&D Engineer, Advanced Engineering, MicroMo Electronics, Inc.



MISSING A PIECE?

We've got you covered! Go to powertransmission.com to see what you missed in last month's issue, plus another eleven years of back issues, industry and product news, and more!

In last month's issue:

- Focus on Gears & Gear Drives
- Spotlight on Maintenance
- Coverage of Pack Expo

... and more!

Power Transmission Engineering

The Future of E-Mobility

Schaeffler Touts System Solutions and Electrification Advancements at Detroit Symposium

Matthew Jaster, Senior Editor

Mobility for Tomorrow was the theme of the Schaeffler Symposium in Detroit, Michigan that took place on September 6th. The event kicked off with discussions on innovations for tomorrow's mobility and the technologies and products driving Schaeffler toward the future.

The company presented technologies for future mobility, including components and system solutions for optimizing internal combustion engine powertrains, the electrification of hybrid vehicles and electric vehicles, and a new vehicle concept.

The Schaeffler Symposium has its roots in the decades-old tradition of sharing advancements and technology during symposiums held every four years in Germany, North America and Asia. This year's Detroit event built on the 11th Global Symposium, held in Baden-Baden, Germany last April, including new developments focused on the North American market.

Urban Vehicle Concept: The Schaeffler Mover

A new urban vehicle concept was featured at the event. The Schaeffler Mover offers a flexible and emission-free platform for a range of different vehicle concepts. All the drive and chassis components are integrated in one unit, called the "Schaeffler Intelligent Corner Module," to save space and enable vehicle maneuverability and passenger



The Schaeffler Mover was on display during the Detroit show.

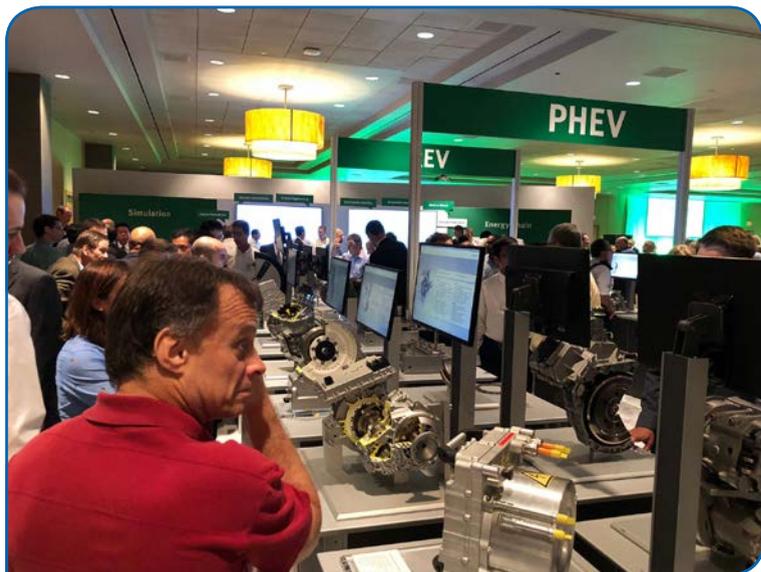
comfort. This concept is Schaeffler's answer to mobility requirements in growing metropolitan areas.

This Module is installed in all four wheels and includes the wheel hub motor, wheel suspension including the spring system, and the actuator for the electromechanical steering system. The steering system of the wheel module is designed as an electromechanical steer-by-wire system. The wheel suspension design selected enables a steering angle of up to 90 degrees. This allows the vehicle to be maneuvered in narrow alleys and be parked in short parking spaces in order to let the passengers enter and exit. Its turning radius of less than five meters makes the vehicle extremely maneuverable in city traffic and even turning on the spot is possible.

The traction motor of the wheel module has been designed as a permanently-excited synchronous motor and is a variant of the wheel hub motor already developed by Schaeffler in a 2013 project. In the current design for the Mover, each of the four electric motors supplies a continuous output of 13 kilowatts and a temporary peak output of 25 kilowatts. The nominal torque of 250 Newton meters per motor can be doubled for short periods.

The Evolution of Clutches, Gears & Bearings

One of the main themes of the event was letting transmission engineers know that there was no reason whatsoever to panic. Matt Frary, vice president, business unit transmission applications, reassured the audience that despite all the electrification going on



Electric and hybrid automotive technologies were on display at the Detroit Symposium.

in the automotive industry—transmission components would remain vital for years to come.

Frary said that the main components of the transmission—gears, clutches and bearings—will be necessary in the future, but their complexity and design characteristics will change with the industry.

There will be fewer gears in an automobile in the future, but the gears that remain will be a higher quality product with unique properties. Bearings will need to perform at high speeds, high currents and produce less noise. Engineers will need to utilize more bearing test rigs to examine loading conditions and failure issues. In the case of clutches, engineers will optimize and redesign the components to make them less complex—remove hydraulic systems and focus on electromechanical automation.

A Look at the Future

The exhibition hall featured several key areas where the organization continues to grow and expand including urban mobility, the energy chain, simulation, powertrain,



An inside look at the wheel hub unit of the Schaeffler Mover.

SUHNER

TRANSMISSION



Automotive shafts

Slightest motion.
Satisfying your highest demands.



SUHNER MANUFACTURING INC
43 Anderson Rd, Rome, GA 30161
706-235-8046
info.usa@suhner.com

SUHNER
EXPERTS. SINCE 1914.

BEYTA GEAR SERVICE

**PUTTING
A LIFETIME**

OF

**GEAR
DESIGN**

EXPERIENCE

TO WORK FOR YOU

- Reverse engineering
- Gearbox upgrades
- Custom gearbox design
- Specification development
- Project management
- Vendor qualification
- Design reviews
- Bid evaluations
- Tooling design
- Customized gear training
- Equipment evaluation
- Custom machine design

Charles D. Schultz
chuck@beytagear.com
[630] 209-1652

www.beytagear.com

Rocky Mountain Technologies State of the Art Custom Design and Consulting Services

Where Innovation and Solutions Meet

- We Deliver Custom Motors and Drives
- We Design Your Custom Motors and Drives
- We Assist with In-House Design and Consulting
- Prototyping, Pre-Production, Product Performance
- Strategic Partners Volume Sourcing



(406) 552-4260

sales@rockymountaintechnologies.com

Rocky Mountain Technologies, P.O. Box 210, Basin, MT 59631



Matt Frary discussed the evolution of bearings, gears and clutches.

surface technology, engine systems and a large emphasis on digitalization.

Product Digitalization

For vehicles, high-speed trains and wind turbines, Schaeffler's mechatronic products are fitted with sensors, electronics and actuators, bearings, and other drive components to provide the information required for big data analysis and business models based on networking.

The goal is to respond more quickly to current developments and to digitize the entire product life cycle. The company has already used its digital capabilities to reduce greenhouse gas emissions in road traffic, generate green electricity using water or wind power more cost-effectively, and to make particularly economical use of fertilizers.

Facing the Challenges Ahead

For the automotive industry, Schaeffler is prepared to be at the forefront of new technologies as vehicles become more efficient, compact and electric.

"Today's auto industry is transforming into a mobility industry," said Jeff Hemphill, CTO, Schaeffler Americas. "Tightening global regulations, new mobility business models and rapidly evolving technologies make designing a vehicle technology portfolio as exciting as it is challenging. (www.schaeffler.us) **PTE**

Power Transmission Engineering

• Technical content free for everyone

• Comprehensive Buyers Guide

• The latest news

www.powertransmission.com

October 31–November 1—Advanced Engineering 2018

Birmingham, United Kingdom. Advanced Engineering will highlight the latest developments in key industries including aerospace, automotive, composites, connected and, digital manufacturing, advanced materials and new for the show this year – civil nuclear new-build engineering. Topics will cover the full range of advanced engineering capabilities, including: design, processing, manufacturing, materials, supply chain, sustainability, testing & measurement, repair and inspection. Featured speakers include representatives from Boeing, Nissan and ALFED as well as several key engineering lectures from Trinity College Dublin. For more information, visit www.easyfairs.com/advanced-engineering-2018/advanced-engineering-2018/.

November 13–16—Formnext Frankfurt, Germany. Formnext is more than an exhibition and conference. It's an entire platform for companies from the world of additive manufacturing. Here, a veritable who's-who from the realms of design and product development, industrial tooling, production solutions, quality management, and measurement technology comes together with leading providers in basic materials and component construction. It will also explore clever ways in which AM can be integrated into process chains in industrial production. In addition, top international speakers and other experts will be on hand to engage conference attendees in in-depth discussions at the highest technical level. For more information, visit www.mesago.de/en/formnext/For_visitors/Profile/index.htm.

December 3–6—CTI Symposium Germany 2018 CTI Symposium Germany provides the latest automotive transmission and drive engineering for passenger cars and commercial vehicles. The international industry event delivers the appropriate platform to find new partners for purchase and sales of whole systems and components. Automobile manufacturers, transmission and component companies give an overview and outlook on technical and market trends including digital manufacturing, IoT, zero-emissions, electric vehicles, hybrid transmissions and more. Speakers include representatives from Audi, ZF, VDA, Valeo, Jaguar, LG Chem, Magna Powertrain and more. For more information, visit drivetrain-symposium.world.

December 4–6—Power-Gen International 2018 Orlando, Florida. Power-Gen International provides comprehensive coverage of the trends, technologies and issues facing the generation sector. Displaying a wide variety of products and services, Power-Gen International represents a horizontal look at the industry with key emphasis on new solutions and innovations for the future. Topics include plant performance, cyber security, energy storage, flexible generation and more. To celebrate the 30th anniversary, the show is awarding 30 scholarships to new attendees. Learn more at www.power-gen.com.

December 5–7—AGMA Steels for Gear Applications Clearwater Beach, Florida. This new AGMA class allows attendees to make use of steel properties in a system solution and understand the potential that different steel options can offer for their various applications. Those in attendance will explore performance of the material and how the steel produced effects the component and system. Objectives include

material properties, selecting materials, verifying and specifying steel properties, and applying methods. Gear engineers, gear designers, material specialists or metallurgists at OEMs, Tier 1s, Tier 2s etc., production engineers, technicians and managers should consider attendance. Instructors include Lily Kamjou, Patrik Olund and Fredrik Lindberg. For more information, visit www.agma.org.

January 7–11—SciTech 2019 From its creation in 1963, the American Institute of Aeronautics and Astronautics (AIAA) has organized conferences to serve the aerospace profession as part of its core mission. Spanning over 70 technical discipline areas, AIAA's conferences provide scientists, engineers, and technologists the opportunity to present and disseminate their work in structured technical paper and poster sessions, learn about new technologies and advances from other presenters, further their professional development, and expand their professional networks that furthers their work. Five focus areas include science and technology, aviation, space, propulsion and energy/defense. For more information, visit scitech.aiaa.org.

January 14–16—A3 Business Forum 2019 Orlando, Florida. The Association for Advancing Automation (A3) Business Forum is the world's leading annual networking event for robotics, vision & imaging, motion control, and motor professionals. Over 600 global automation leaders attended the 2018 show. A broad range of companies participate including Amazon, Ametek, GM, Fanuc, ATI, Gudel and more. The event includes keynote and breakout sessions on the human exploration of Mars, a global economic outlook, automation market update, trends in robotics, responsible artificial intelligence and others to be announced. Networking opportunities include a golf scramble, a wellness walk, and a first timer's reception. For more information, visit www.a3automate.org/a3-business-forum/.

January 22–25—World of Concrete 2019 Las Vegas, Nevada. Original equipment manufacturers from around the world and exclusive U.S. distributors of equipment, tools, products and services for the commercial construction, concrete and masonry industries attend World of Concrete. The show attracts approximately 1,500 exhibitors and occupies more than 700,000 net square feet of indoor and outdoor exhibit space. World of Concrete is the premier event for the commercial construction trades. Education tracks include engineering, safety and risk management, general business, business and project management and concrete 101. Interactive workshops include trainer training, construction boot camp, sales and more. For more information, visit www.worldofconcrete.com.

February 12–14—IPPE 2019 Atlanta, Georgia. The International Production & Processing Expo is the world's largest annual poultry, meat and feed industry event of its kind. A wide range of international decision-makers attend this annual event to network and become informed on the latest technological developments and issues facing the industry. The 2019 show will expand to all three halls of the Georgia World Congress Center. It will bring more than 1,200 exhibitors and 30,000 attendees to Atlanta to discuss innovations in production and processing. Note that the date has been moved to accommodate the Super Bowl coming to Atlanta in 2019. For more information, visit www.ippexpo.org.

BSA

ANNOUNCES 2018 EXCELLENCE AWARDS

On Monday evening, September 17, 2018, BSA President, Jim Scardina, Bearing Headquarters, presented the Annual BSA Excellence Awards for outstanding service by bearing distributors and bearing manufacturers to the end use customer. The Bearing Manufacturer Excellence of Innovation in Product Design Award recognizes companies for innovation and excellence in product design or technology. BSA distributor members reviewed and ranked manufacturer innovation submissions. Among the abundance of innovative product designs submitted, three submissions were chosen to be recognized for their outstanding service to the end use customer.

The first Manufacturer Excellence Award was presented to NTN Bearing Corporation of America for the Sentinel Series. This is NTN Bearing Corporation of America's second Manufacturer Excellence Award. Beyond NTN's world renown bearing quality, they have the capability of offering unique solutions to their customers' needs. One way they seek solutions to bearing problems is to look further, to the application itself, and see how NTN can assist and offer solutions that the customer may never have considered. NTN's Sentinel Series is a product line born from understanding the applications within the Food and Beverage industry.



NTN's Sentinel Series is a premium line of corrosion-resistant products developed for the harsh conditions of the food & beverage industry. With available products ranging from deep groove ball bearings to bearing inserts to mounted units available in numerous combinations of housings, protective covers, grease and sealing options, Sentinel Series provides a family of Food and Beverage market solutions to improve overall equipment effectiveness, increase production, and provide value.

Scott Eiss, vice president, industrial aftermarket sales of NTN Bearing Corporation accepted the Award on behalf of NTN Bearing Corporation for the Sentinel Series.

The second Manufacturer Excellence Award was presented to Regal Power Transmission Solutions for the Sealmaster Time Saving Axial Groove Mounted Ball Bearing. The Sealmaster Time Saving Axial Groove Mounted Ball Bearing is available in both a medium 2 7/16" and up and standard 2 11/16" and up shaft sizes, the Time Saving axial groove in the inner ring bore allows for easier bearing removal. This design provides clearance from the burr created by the setscrew



Regal Sealmaster Time Saving Axial Groove Mounted Ball Bearing.

used to lock the bearing to the shaft, which makes removal difficult and can cause damage to the shaft during removal. This reduction in damage to the shaft not only then reduces the cost associated with repairing the shaft before reuse, it can eliminate the cost of having to replace the shaft.

This is the only bearing product on the market that has an axial groove on the inner ring bore that provides clearance from the burr created by setscrews. The Time Saving Axial Groove design allows customers to remove their bearings in the field quicker, reducing the amount of extended downtime during bearing removal and saving customers money on shafting replacement costs.

Chad Hartley, vice president and business leader — bearings and components for Regal Power Transmission Solutions accepted the Award on behalf of Regal Power Transmission Solutions for the Sealmaster Time Saving Axial Groove Mounted Ball Bearing.

The third Manufacturer Excellence Award for outstanding service to the end use customer was presented to The Timken Company for the Timken Type E Tapered Roller Bearing Housed Unit Secondary Sealing System. Timken recently made the most robust sealing system in the industry



Timken Type E Tapered Roller Bearing Housed Unit Secondary Sealing System.

Gear Motions

ANNOUNCES NEW DIRECTOR OF OPERATIONS AND CORPORATE CONTROLLER

for Type E Housed Unit mounted bearings even better. This product offers an unrivaled multipoint sealing system with 9 points of sealing.

The upgraded triple-barrier internal seal provides two contact lips and one rigid middle labyrinth section to help retain grease and reduce contamination ingress. New enhanced seal material helps provide greater performance with two times more abrasion resistance than the industry standard nitrile seal. The locking collar and grease in cavity of the end cover provide additional sealing protection as well as a triple-lip external rubber through shaft seal. The external seal secondary cover closes it all into the unit.

The Timken unrivaled multi-point sealing system helps the Type E mounted bearing last longer against contamination and moisture. It also provides housed units with extra protection for rugged, cost-effective covers designed to fight heavy contamination in industries where particulates are a challenge. This system helps keep your bearings performing, even in harsh, dirty applications with the higher abrasion-resistant triple-barrier internal seal.

A sand and gravel company in Alaska installed Timken Type E Tapered Roller Bearing Housed Unit Secondary Sealing System for their inclined screw conveyor. The bearings were installed as a pilot at the end of 2015. Previous bearing life before the Type E with end covers was four months. Since installing the Timken Type E with covers bearings ran successfully for approximately two years.

Doug Knauf, vice president of US Distribution and Regional OEMs of The Timken Company, accepted the Award on behalf of The Timken Company for the Timken Type E Tapered Roller Bearing Housed Unit Secondary Sealing System.

The 2018 BSA CBS Excellence Awards recognized BSA Distributor Companies with the highest percentage of their inside and outside sales force's having attained CBS status as well as the greatest percentage increase of its inside and outside sales force having attained Certified Bearing Specialist status. BSA's Certified Bearing Specialist (CBS) program is the only bearing industry-specific program that identifies and quantifies the specific skill sets to certify an industry professional as a bearing specialist.

BSA recognized a company with an Honorable Mention for this Award. B&D Industrial received special recognition for the number of Certified Bearing Specialists within their sales force.

The CBS Excellence Award recognizes the esteemed regard of the CBS designation and the industry as a whole.

The recipient of both the 2018 CBS Excellence Awards for outstanding service to the bearing end use customer was BDI Canada Inc. Giovanni Chiricosta, vice president of sales, of BDI Canada, Inc. accepted the award for BDI Canada. (www.bsahome.org)

Gear Motions announces long-time employee Dan Bartelli has been promoted to director of operations of Nixon Gear, and Anna Pastore has been hired to the position of corporate controller.

This year **Dan Bartelli** is celebrating his 30th anniversary with Nixon Gear, a division of Gear Motions. This notable anniversary also comes with a well-deserved promotion; Bartelli has recently been promoted to director of operations.



Bartelli began his career at Nixon Gear in 1988 as a machinist where he distinguished himself as a quick learner and hard worker. He worked in a number of departments, and before long was promoted to lead machinist. From the shop, Bartelli moved to customer service where he demonstrated a natural talent for outstanding customer care. It was here that Dan established his skill for scheduling and planning and was promoted to master scheduler. In 2010 Dan was promoted to manufacturing manager and most recently to director of operations.

In his new role, Dan is responsible for all Nixon Gear Division Operations including manufacturing, quality, and engineering. He is an integral part of the management team, providing leadership and direction to the entire Nixon Team. With his guidance, the Team will continue to deliver high quality products, meeting and exceeding customer requirements and industry standards.

Additionally, Gear Motions recently hired **Anna Pastore** to join the company as corporate controller. Pastore brings a positive attitude and many years of finance and accounting experience to the team.



Pastore graduated with an MBA from Chapman University, and received an undergraduate degree from Lemoyne College. She previously served as director of finance for Cascade & Maverik Lacrosse, and vice president of finance of the produce and technology division at Agway. In her spare time, Anna serves on the Board of HumaneCNY Animal Shelter, and loves to travel. She is married, has two grown sons and a beloved dog.

Pastore is looking forward to using her experience and enthusiasm to grow the accounting department and help bring the company to the next level. (gearmotions.com)

ISA

ANNOUNCES APPOINTMENT OF EXECUTIVE DIRECTOR

The International Society of Automation (ISA) recently announced the appointment of automation industry veteran **Mary Ramsey** as its new executive director.

Ramsey, who has been serving as ISA's interim executive director since January of this year, has more than 25 years of industrial automation experience. She specializes in leadership, change management and strategy development/execution. Prior to serving as ISA's interim executive director, she was the senior vice president of Process Automation, Americas Region, at Schneider Electric, where she was responsible for a \$550 million profit/loss statement and 1,200 employees. She has also served as senior vice president of Industry Business USA and senior vice president of Industry Business Europe within Schneider. Prior to joining Schneider Electric, Ramsey held several business development roles within Matrikon International; Instrinsic; Intellution, Inc.; and GE Fanuc, among others.



"Mary is a dynamic, experienced leader with a deep understanding of automation and the industries we represent," said 2018 ISA President Brian Curtis. "She has proven her ability to think strategically and help the organization align its priorities during her tenure as interim executive director, and we are thrilled to welcome her on board permanently."

A search committee comprised of nine ISA members and leaders from around the world worked to review dozens of resumes and conduct a series of interviews over the last several months. The committee's work resulted in a recommendation to appoint Ramsey.

"The search committee has dedicated significant time and effort to make this decision. We are confident that Mary's leadership and extensive experience will serve the organization, its members and the automation community well for years to come," said Executive Search Committee Chair Steve Pflantz.

"It's an honor to serve as ISA's executive director," said Ramsey. "I'm excited to work with staff, members and leaders to bring a fresh perspective to this important organization. ISA is truly unique in its ability to bring the automation community together to solve difficult technical problems and provide leadership on critical issues facing our industries. We have a lot of work to do, and with the help and support of individuals and companies around the world, we will advance ISA's mission and create a successful future."

Ramsey holds a bachelor of science in electrical engineering (BSEE) degree from the University of Kentucky and a master of business administration (MBA) degree with a specialty in finance and strategy from Loyola University. (www.isa.org)

CCTY Bearing

COMPLETES EXPANSION

CCTY Bearing has expanded its forging capabilities with a new factory. In addition to more space for forging, the facility has onsite turning and heat treatment.

Completed in August 2018, the nearly 12,000 square meters facility was constructed directly in front of the old building expanding the total work area to 22,000 square meters. Both buildings, which triple the original capacity, will be used to accommodate increased production levels.



"Up until this factory was built, tie rods were the only component that needed to be outsourced for forging," said Bob Zhao, CCTY Bearing president. "Now we have complete in-house control over all aspects of forging."

The new facility and 120 skilled employees allow CCTY Bearing to forge tie rods ranging in size from small linkages to those that are more than five feet for heavy trucks. Crimping, welding and threaded options, along with heat treatment, are available from the Xuyi, China location.

"When combined with the other onsite critical processes like welding and PTFE weaving, it is easy to see why we are able to consistently produce highly precise bearings," said Evan Poulakidas, CCTY Bearing North American director.

CCTY Bearing has a history of investing in tooling, equipment and capacity. In 2016, the company moved into a new 70,000 square meters factory in Zhenjiang, China. The upgraded plant includes the latest in robotic technology, on premises research and development, testing labs and warehousing.

Tours of both plants are available to existing customers and can be coordinated with sales representatives. (www.cctybearing.com)

Motion Industries, Inc.

ANNOUNCES VICE PRESIDENT OF MARKETING

Motion Industries, Inc., a leading distributor of maintenance, repair, and operation replacement parts and a wholly owned subsidiary of Genuine Parts Company, announced the promotion of **Pamela Sims** to vice president of marketing, effective September 1, 2018.



A graduate of the University of Alabama at Birmingham, Sims joined Motion Industries in 2004, starting in market research. Her career quickly evolved, and she most recently served as the company's director of marketing since 2013. During this time, she developed and implemented various marketing plans to position Motion Industries as a leading industrial distributor.

Sims has also developed outstanding relationships with the company's top strategic supplier partners, working with them to implement Motion Industries' extensive co-op advertising program.

Randy Breaux, Motion Industries executive vice president of marketing, distribution, and purchasing, said, "Pamela has done an excellent job for Motion Industries and is well-deserving of her expanded responsibilities. We look forward to her future contributions as she continues to develop and implement Motion's comprehensive marketing plans."

(www.motionindustries.com)

QA1

CELEBRATES 25 YEARS

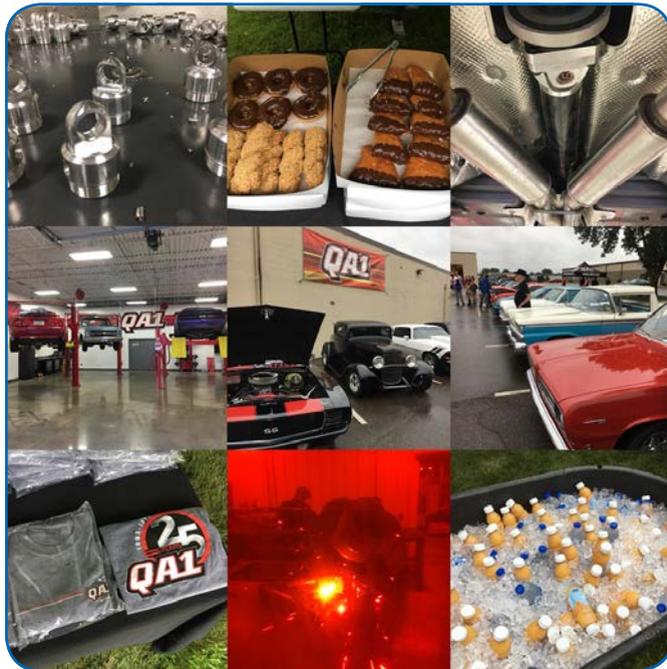
QA1 opened its facility to the public for the seventh year in a row on the morning of Friday, July 20. The open house is a two-hour event that brings enthusiasts together for a more intimate gathering before they cruise up to the Minnesota State Fairgrounds for the Street Machine Nationals in St. Paul. This year's event brought approximately 200 people through the QA1 facilities, braving the gray and misty weather, to help celebrate QA1's 25th year of business.

During the tours, participants gained an inside look at QA1's daily operations and continuous growth through new machinery and products. "I was impressed with the new CNC machinery," said one attendee. "All through the tour, I saw company growth, and that is something to be proud of." They saw manufacturing in action, from carbon fiber winding for driveshafts to welding tubular components to CNC machining and shock assembly.

To commemorate QA1's 25 years, the open house also included games for attendees with the opportunity to win a variety of QA1 prizes, from aluminum signs and pint glasses to \$2500 in QA1 cash gift certificates. Other prizes included a variety of items from Summit Racing Equipment, Intercomp, Mothers, JEGS, and local area restaurants.

Once again QA1 selected a Ride of the Year winner, who

this year was Marshall Holt of Lakeville, MN. He brought his 1930 Willys Whippet Coupe, which was built from an old circle track chassis and has a custom-made body. "With the large variety of vehicles that come to our open house, it's tough to pick just one Ride of the Year, but when Marshall pulled in, everyone took notice," says QA1's Steve Smith. "It's a really cool mix of parts that make up the car, and it really exemplifies the #goDRIVEit spirit."



When the tours were over and the prizes and awards were all handed out, approximately 100 cars continued the party and cruised to the Minnesota State Fairgrounds, where participants gained VIP preferred entrance to the Street Machine Nationals. QA1 is proud to sponsor the autocross at this event, where a range of muscle cars and trucks collectively ran nearly 1,000 passes throughout the weekend. (www.qa1.net)

AGMA

UNVEILS MOTION + POWER TECHNOLOGY EXPO

The new Motion + Power Technology Expo (MPT Expo), formerly Gear Expo, has announced its inaugural event in October 2019. This unique trade show and conference, will bring 4,000 professionals looking for technical solutions from across the Mechanical Power Transmission, Fluid Power and Electrical Drive industries for three days of educational



MOTION + POWER
TECHNOLOGY EXPO

sessions, networking, and a full exhibit hall featuring industry leading companies. Motion + Power Technology Expo will take place at the Cobo Center in Detroit, MI, October 15-17, 2019 and is owned and operated by The American Gear Manufacturers Association (AGMA).

The new Motion + Power Technology Expo will feature 80,000 net square feet of space, and include 300+ exhibitors from across the supply chain including gear companies, machine tools suppliers and electric drive solutions. The National Fluid Power Association (NFPA) will be a co-sponsor of the show, and will host a 5,000 set square foot Pavilion within the show, featuring 50 exhibitors.

“We are excited to transform Gear Expo into the MPT Expo with our partners including the National Fluid Power Association (NFPA). This is much more than a name change; through MPT Expo, AGMA is transforming the legacy of Gear Expo to include solutions from the mechanical, fluid and electric industries,” said Matthew Croson, president, AGMA. “By creating a wider focus, exhibitors will have the opportunity to connect with more buyers from a wide variety of industries, and attendees will be presented with all three power transmission solution sets in one place. MPT Expo will be a great place to see and test out all of the latest advances in the industry.”

With such important industry partnerships like the one created with NFPA, both associations are dedicated to keeping a technically-focused education program. Those in attendance will be offered a wide-ranging series of informative seminars taught by industry leaders and insiders. MPT Expo will be a convenient and affordable destination to advance one’s knowledge of the industry, hone technical skills, and dive into the latest research and technical developments. Additional information about MPT Expo and new association partnerships will be released over the next few months.

Hundreds of companies have already signed up for exhibit space on the show floor, including industry leaders Timken Power Systems, Meritor, EMAG LLC, Gleason Corporation, Klingelnberg, Kapp Group, Mitsubishi Heavy Industry America, and others. (www.motionpowerexpo.com)

IDC-USA

MERGES WITH AD

AD, the contractor and industrial products wholesale buying/marketing group, announced today the merger with IDC-USA, effective January 1st, 2019. This merger brings together the two largest independent Bearings & Power Transmission buying/marketing groups in the United States. IDC-USA adds 76 new members with 250 branch locations to the AD family, as well as redistribution centers in Indiana and Nevada and 27 employees.

Chris Hughes, board chairman of IDC-USA and president of Transmission & Fluid Equipment, Inc. reacts, “Voting to join AD was an easy decision for me, as I suspect it was for the majority of my fellow IDC independents. Frankly, with AD’s recent transition to a member owned organization, it made the decision that much easier. By merging IDC into

AD, we get the best of both worlds; programs and services we value from IDC, expanded supplier and member relationships, and the multi-divisional scale and infrastructure of AD. It’s a win-win for all independent distributors.”

Ryan Watts, AD Bearings & Power Transmission board chair and president of Apex Automation LLC comments, “This merger certainly helps to strengthen the industry on many fronts. The critical mass of our combined membership will enable us to support our supplier partners even more than we already do. In addition, the opportunity to network and share best practices with so many quality independent distributors provides perhaps, the most powerful aspect of being with AD.”



(Left to right) Jack Templin (AD), George Graham (IDC-USA) and Chris Hughes (IDC-USA) on the day the IDC members voted to join AD.

As a part of the merger, IDC-USA President & CEO George Graham will take on the role as President of the AD Bearings & Power Transmission Division.

George Graham, IDC-USA president & CEO, says, “I am very pleased to have helped bring about this unification of great independents. The Bearings & Power Transmission industry is highly consolidated with strong national chains that we highly respect. But there’s a place in this industry for independent distributors too, and there always will be. In fact, we hope that distributors not currently aligned with a group will consider joining this new AD Division.” Graham continues, “Personally, I am excited to join the AD team and the engaging culture they work so effectively to build. AD Industrial President, Jack Templin and AD Chairman & CEO, Bill Weisberg handled this merger with total respect and professionalism. Everyone I meet at AD has the single focus to help their members, supplier partners and associates to grow and prosper.”

Bill Weisberg, AD Chairman & CEO, said, “We are honored to welcome IDC-USA members, suppliers and staff into the AD family. A major component of our strategy is to provide value added services to support the overall growth of our members and suppliers. Over the last 37 years, we’ve done six startups and now eight mergers and the resulting scale brings real value to our owner members and partners. I continue to see solid growth in the years ahead – both in terms of our footprint, as well as our range of services.” (www.adhq.com)

Gilman Precision

ADDS PHILLIPS TO BUSINESS DEVELOPMENT TEAM

Gilman Precision, manufacturer of customized linear and rotary motion systems, is pleased to announce the addition of **Patrick Phillips** to their sales force as a business development specialist.



Phillips will oversee the Midwestern territory of Indiana, Michigan, and Ohio. He will play an important role in facilitating the connection between engineers and customers, creating smooth communication and cultivating positive customer relations. Phillips will aid clients by addressing their unique needs and assisting them towards the most efficient solution to their linear or rotary motion challenge.

Phillips has several years of experience working in the sales and customer service industries, with previous positions as a property and casualty claims representative and business analyst. Phillips is diligent and values strong interpersonal communication, and is “thrilled to join the Gilman team and exceed your expectations.”

Doug Biggs, vice president of sales and marketing commented, “We are very excited to have Patrick join our Business Development team. We believe his skill set and experience will help further expand our company by creating new opportunities and increasing value in customer interactions.” (www.gilmanprecision.com)

Bonfiglioli and CVTCORP

ENTER LICENSING AGREEMENT

CVTCORP and Bonfiglioli have announced they have entered into an exclusive licensing agreement for Bonfiglioli to manufacture and sell the CVTCORP mCVT patented technology for telehandlers and other equipment. The cooperation between Bonfiglioli and CVTCORP will also include developing a full line of transmissions based on the currently available mCVT.



Included in this licensing agreement is the production transfer of the Ecomec 150, used in the Skyjack Ecoshift telehandler, along with the CVTCORP current sales pipeline with commercialization volume anticipated at the beginning of 2020.

CVTCORP has developed a high-power, efficient and cost-effective mCVT which is currently available as the Ecomec 150, used in the new Skyjack Ecoshift telehandler. The CVTCORP’s mCVT patented technology, the result of over 15 years of development, offers off-highway manufacturers a fully validated and scalable solution that provides unmatched operational ease, engine downsizing opportunities and overall vehicle performance improvements in the 20-30% range.

Bonfiglioli, after the acquisition of O&K in 2015, has become the provider of the largest geared drives range in the market for applications in construction, mining and material handling equipment, driving machine sizes ranging from 1 ton to over 1,000 tons. The continuous improvement in design, proven quality standards and operational excellence recognized by the most respected machine manufacturers worldwide have confirmed, after 40 years of experience in the sector, Bonfiglioli as the geared drives market benchmark.



“Bonfiglioli’s endorsement of our mCVT technology and their reputation as a high quality, global manufacturer will accelerate the commercialization of our technology worldwide starting with telehandlers applications,” said Daniel Girard, founder and CEO of CVTCORP. “We are looking forward to assisting Bonfiglioli with moving forward rapidly into markets where our innovative mCVT technology enables engine downsizing, fuel reduction, increased safety and productivity,” Girard added. “CVTCORP will work with Bonfiglioli to continue its development of advanced controls and connectivity capabilities to optimize complete vehicle performances and provide customers equipment with simple but cutting-edge technology.”

“Over the last several years, we have worked very intensively to enhance and enlarge our product portfolio in our core markets with excellent responses from our customers. A couple of years ago, when we came across CVTCORP’s technology, it was clear we were in front of a ‘game-changer’ and we immediately recognized the differentiating features such technology was offering and the diversification opportunity for our company leveraging on our market, technology and operational core competences,” says Fausto Carboni, Bonfiglioli CEO. (www.bonfiglioli.com)

CALL FOR PAPERS!

Are you sitting on an idea for a technical paper but wondering where to present it? Do you have one already written, sitting on your desk, gathering machine dust?

How about *Power Transmission Engineering*? We are always looking for gearing- and power transmission component-relevant technical papers for publication in the magazine and in its digital version. Having your work appear in *Power Transmission Engineering* guarantees you an audience of the most experienced and discriminating industry players. You say your work has not been peer-reviewed? Not a problem, as we are lucky—and thankful—to have on-hand some of the most experienced and brilliant minds in the industry—our technical editors. So if your work “passes muster” and is published, you’ll know you were reviewed by the best—and most demanding.

Chances are you’ll be creating the paper under the auspices of the company for whom you work or own, or for one of the various industry-relevant associations. That means they as well will bask in the reflected glory that accrues with publication in *Power Transmission Engineering*.

For publication guidelines and more information, please contact Jack McGuinn at jmcguinn@powertransmission.com.

ABB

Page 3
new.abb.com/motors-generators

Automate Show

Page 27
www.automateshow.com

B&R Machine and Gear

Page 29
www.brgear.com

Beyta Gear Service

Page 45
www.beytagear.com

Brother International

Inside Front Cover
www.brothergearmotors.com

Circle Gear

Page 21
www.circlegear.com

Diequa Corp.

Pages 19, 28
www.diequa.com

Dorris Gear Drives

Page 29
www.dorrisco.com

Excel Gear

Page 13
www.excelgear.com

Forest City Gear

Page 23
www.forestcitygear.com

Gearench

Page 2
www.gearench.com

Lafert North America

Page 20
www.lafertna.com

Lubriplate

Page 7
www.lubriplate.com

McInnes Rolled Rings

Page 14
www.mcinnesorledrings.com

Miki Pulley

Page 10
www.mikipulley-us.com

Molon Motor and Coil

Page 12
www.molon.com

Nordex Inc.

Page 29
www.nordex.com

Philadelphia Gear

Page 11
timkenpowersystems.com/resteasy

R+W America

Page 9
www.rw-america.com

Riverside Spline and Gear

Page 28
www.splineandgear.com

Rocky Mountain Technologies

Page 46
www.rockymountaintechnologies.com

Schaeffler Group

Back Outside Cover
www.schaeffler.us

Sesame Motor Corp.

Page 15
www.sesamemotor.com

SEW-Eurodrive

Inside Back Cover
www.seweurodrive.com

Suhner

Page 45
www.suhner.com

Zero-Max

Page 5
www.zero-max.com

Power Transmission Engineering®

FREE SUBSCRIPTION

18PTEALL

- YES** I want to receive/continue to receive *Power Transmission Engineering*
- NO** Thanks anyway, but I don't need the world's best publication on mechanical components.

Name _____ Job Title _____
(please print)

Signature _____ Date _____
(required)

How would you like to receive *Power Transmission Engineering*?

- PRINT Version (Verify mailing info below)
- DIGITAL Version (E-mail required)
- BOTH Print AND Digital (E-mail required)

E-mail _____ *

How is THIS LOCATION involved with power transmission products? (Check all that apply)

- WE MAKE power transmission products
- WE BUY power transmission products
- WE SELL power transmission products (Distributors, sales reps, etc.)
- WE DESIGN products with power transmission components in them
- Other (please describe) _____

What is your company's principal product or service? _____

***Your PRIVACY is important to us. You get to CHOOSE how we use your personal information. The next e-mail we send you will have clear instructions.**

MAILING INFORMATION

NAME:

JOB TITLE:

COMPANY:

ADDRESS:

- Check if this is a home address

CITY:

STATE/Province:

ZIP/Postal Code:

PHONE:

FAX:

Put your business card here to make it easier!



Mail to:
1840 Jarvis Ave., Elk Grove Village, IL 60007 USA

or

FAX to 1-847-437-6618
SCAN to: subscribe@powertransmission.com

The World's Most Famous Mass Damper

Alex Cannella, Associate Editor

Marvels of engineering have always drawn crowds. But when we think of tourist destinations, we think of old, opulent buildings like the Vatican or Versailles, massive, elaborately designed fountains, or skyscrapers like Chicago's own Sears Tower (no, I will not call it the Willis Tower).

These are all buildings designed with prestige, not practicality or profit, in mind. A skyscraper is actually more expensive to build than two buildings of half its height, but there's prestige and fame in being the tallest, and people have proven time and again that those less tangible benefits are worth pursuing.

So when we think of a tourist attraction, we're more likely to think of a skyscraper itself than a giant tuned mass damper—a plain engineering practicality—inside of it. But that's exactly what Taipei 101's tuned mass damper, a 728-ton steel orb suspended from five stories of steel cable, has become. It's got informative placards, voice tours and everything.

It certainly helps that Taipei 101 is already a famous skyscraper on its own. It had been the tallest skyscraper in the world until it was outstripped by the Burj Khalifa in 2010. It also used to have the world's fastest elevator and is still the largest "green" building in the world. But the supertall tower's mass damper has become a centerpiece of sorts for the building in the same way many skyscrapers' observation decks are.

Gawkers aside, the mass damper's primary function is obviously an engineering one. Tuned mass dampers are devices developed to reduce mechanical vibrations in buildings such as skyscrapers. When a skyscraper starts blowing in the wind, Taipei 10's mass damper works as a counterweight, gently rolling on hydraulic cylinders to counteract and reduce the building's movements from forces like the wind. It's just one of the many ways skyscrapers are designed to provide a flexible frame that won't be damaged by everyday stresses.

The mass damper in Taipei 101 has to contend with more than just the wind, however. It's just 660 feet from a major fault line, and earthquakes are a significant threat. And a few years back, the mass damper was given its greatest test in the form of Typhoon Soudelor, which moved the damper an entire meter from its resting position, the farthest it's ever been pushed. Through it all, Taipei 101 has remained



Tuned mass damper on display in Taipei 101. Photo by Armand du Plessis (CC BY 3.0)

standing, earning it the title of "world's toughest" building by *Popular Mechanics* almost exactly three years ago in no small part because of its mass damper.

Usually, most construction elements such as this mass damper would be hidden away from sight. There's even a pair of far less accessible dampers in the same building that are tucked away in the tip of its spire. But the designers purposely left the shaft the main mass damper hangs down open, making the mass damper freely visible from all five of the floors it dangles past. While every other one of the building's bones are hidden, this single one is laid bare, a small engineering marvel for curious onlookers.

The mass damper is so popular that it even has its own mascot: Damper Baby. The little mascot was developed by Sanrio, the Japanese company of *Hello Kitty* fame. Aside from , its torso is the mass damper itself. All in all, it kind of looks like a sort of bee person, or at least the yellow version does. The mascot even comes in five colors and provides both decoration for the damper's immediate surroundings and something to line the shelves of Taipei 101's gift shops.

The skyscraper's mass damper is curiously popular enough to almost be labeled an icon, and is irreversibly connected to the image of one of the world's famous modern supertall skyscrapers, all while still doing its job of maintaining the stability of said skyscraper. It's an impressive bit of work, so if you ever find yourself in Taiwan, be sure to visit it and check out a modern power transmission engineering marvel. **PTE**



Size matters.

Especially with gearmotors...

Too **small** = premature failure

Too **large** = high cost & low efficiency

Unsure of your drive size? Then go online to PT Pilot®. Simply enter the parameters of your hoist, conveyor, or travel car. PT Pilot® will automatically calculate the optimal horsepower, speed, and gear unit – with or without a VFD.

PT Pilot® also provides documentation, pricing, and a 3D CAD drawing for every selection. Visit ptpilot.com.

SEW
EURODRIVE

— Driving the World —



Looking to give your bearings maximum protection against electrical arcing damage? Look to Schaeffler.

The problem: Damage caused by electrical current passing through bearings in electric motors.

The solution: Current-insulated bearings from Schaeffler — including hybrid ceramic or ceramic-coated versions featuring our proprietary Insutect™ coating — that have been engineered to stop stray electric current in its tracks!

Now that's electrifying!