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OCTOBER 2020

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# Power Transmission Engineering®

OCTOBER 2020

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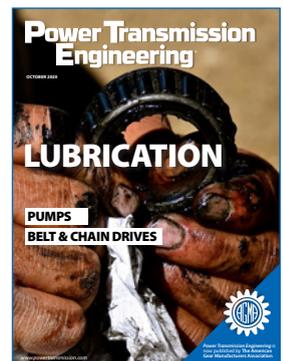
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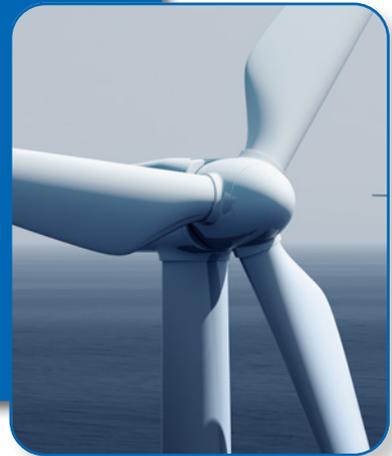
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### PTE Videos

#### NSK Saves Wind Energy Application

*NSK engineers investigated and developed a solution with a bearing design specific to the application. With this solution, it was not necessary to scrap the shafts which saved replacement costs. The special bearings were assembled following grinding of the shafts. Learn more here:*

[www.powertransmission.com/videos/NSK-Wind-Energy-Success-Story/](http://www.powertransmission.com/videos/NSK-Wind-Energy-Success-Story/)



#### Gear Lubrication with Lubrizol

Lubrizol takes a look at the importance of industrial gear lubrication here:

[www.powertransmission.com/videos/Industrial-Gear-Lubrication-with-Lubrizol/](http://www.powertransmission.com/videos/Industrial-Gear-Lubrication-with-Lubrizol/)



#### Amorphology: A New Paradigm for Precision Gear Manufacturing

View this recorded webinar from Amorphology where they break down the science behind their unique Bulk Metallic Glass (BMG) processing. Amorphology CTO, Dr. Glenn Garrett, details the journey that BMGs have made to present day applications such as gears and robotics. Learn more here:

[www.powertransmission.com/videos/Webinar:-Flipping-the-Precision-Gear-Manufacturing-Paradigm/with-Lubrizol/](http://www.powertransmission.com/videos/Webinar:-Flipping-the-Precision-Gear-Manufacturing-Paradigm/with-Lubrizol/)

#### Upcoming Events Pack Expo Connects

Pack Expo Connects takes place November 9-13, 2020 offering virtual chats, educational content, live machine demonstrations and more. Daily Jumpstart sessions will examine topics such as sustainability, workforce development, and robotics. Trend chats will cover everything from food processing and pharma to digital printing and cannabis packaging. Learn more here:

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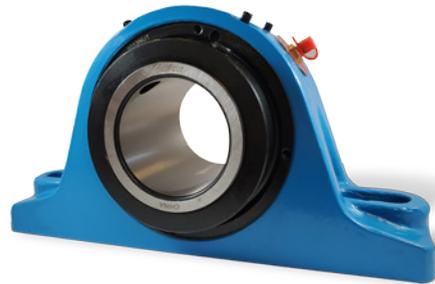


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# Answer the Call



About once per year, we make a concerted effort to get you, our readers, to renew your subscriptions to *Power Transmission Engineering*. Well, it's that time again. Those of you who have not renewed within the past year will likely be hearing from us by phone or e-mail.

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When you sign up or renew, you'll continue receiving great issues like this one. We have an outstanding technical article this issue on motors, controls and signal noise from our motors columnist Donald Labriola. Plus, we have additional feature and technical coverage of lubrication, pumps and belt and chain drives. As always, we try to cover the complete spectrum of mechanical power transmission, with technical news and engineering examples to help you understand the best technology for your own applications.

Just as importantly, we have a lot of great information planned for the future, including our annual buyers guide in the December issue and lots of great topics scheduled for 2021.

So please take a few moments and help us ensure that you'll continue to receive *Power Transmission Engineering* without interruption and in the format you prefer. It really does go a long way toward helping us continue to provide - free of charge - the only magazine that focuses on the full spectrum of mechanical power transmission solutions.

A large, stylized handwritten signature in black ink that reads "Randy Stott". The signature is written in a cursive, flowing style.

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# Eaton

## EXPANDS REMANUFACTURING PROGRAM TO INCLUDE ELECTRONIC CLUTCH ACTUATORS

Eaton has announced its Vehicle Group is expanding its remanufacturing program to offer remanufacturing of electronic clutch actuators used on Eaton UltraShift PLUS transmissions. Eaton remanufactures thousands of transmissions and clutches annually to maximize the reuse of materials, keep them out of landfills, save energy and reduce emissions and waste.

Eaton's remanufacturing business recovers core product components from customers across North America and returns them to "like new" performance. Using improved cleaning processes and advanced inspection techniques to validate weld integrity, components in good working condition are reused whenever possible.

"Remanufactured products provide customers with a cost-effective solution while offering a sustainability advantage," said Tim Bauer, vice president, Aftermarket, Eaton's Vehicle Group. "In addition, remanufacturing options carry market competitive warranties, providing additional peace of mind for fleet operators of all sizes."

By expanding its remanufacturing business and remanufactured product portfolio, Eaton strives to minimize the environmental impacts from manufacturing new parts. The remanufacturing strategy aligns with Eaton's recent announcement to join the global movement to limit the increase of the world's temperature to 1.5 degrees Celsius by committing to science-based targets. In support of this effort, Eaton has a target to have remanufactured products account for up to 80 percent of its aftermarket transmissions by 2023.

All factory remanufactured products are backed by Eaton's Roadranger sales and service network, the nation's leading support system for drivetrain components, which provides unequaled protection, support, and training from experienced professionals.

In addition to its efforts to service the market with factory remanufactured transmission products, Eaton



Eaton has expanded its remanufacturing to provide customers with a sustainable alternative.

has established a network of authorized rebuilders across North America. The authorized rebuilders have specific training, parts, testing, and validation requirements designed to provide consistent quality of remanufacturing transmissions to fleet operators.

Authorized rebuilders are regionally located across North America to provide a broad coverage of products to maximize fleet uptime. These authorized rebuilders have similar part reuse criteria and provide the same environmental benefit as buying a factory remanufactured transmission. Eaton's authorized rebuilder remanufacturing programs are designed to have an inventory of remanufactured products strategically stocked throughout North America to maximize vehicle up-time.

"Our remanufacturing strategy will continue to evolve to ensure we minimize our environmental footprint on the environment long-term, and we've already identified additional electronics products to be launched through the remainder of 2020 and 2021," said Bauer.

### For more information:

Eaton  
Phone: (248) 226-6462  
Eaton.com

Regal's SS Hera is a hassle-free replacement option for worm speed reducers.



# Regal Beloit

## EXTENDS HERA RIGHT ANGLE GEAR DRIVE SERIES

Regal Beloit Corporation has announced a line extension of the Hub City SS (stainless steel) HERA High Efficiency Right Angle Gear Drive.

Regal has added two new sizes to the IP69K certified SS version of this helical-hypodial gear drive to this product suite with the stainless steel 55 and 75, taking the torque range to 8,500 in-lbs. Worm gear drives are generally not as efficient as helical gears and become less efficient the higher the ratio. The SS HERA Gear Drive is 90% efficient, regardless of ratio.

“The line extension of the SS Hub City HERA Gear Drive is designed to be a no-hassle replacement of major brands of worm speed reducers and also provides a highly efficient right angle gear solution for new applications,” said Mike Suter, vice president, marketing, Regal. “SS HERA offers four models that can replace up to a dozen sizes of worm reducers. This interchangeability can help with inventory consolidation.”

The SS HERA, with polished 316 stainless steel housings, is IP69K-certified to withstand sustained high-temperature, high-pressure washdown.

It is also HACCP-compatible and BISSC-certified.

The SS HERA can be bundled with Leeson Stainless Washguard all-stainless motors. It is available with the HubLoc keyless bushing system and new stainless steel, HubCap bolt-on split covers.

Regal offers online tools and apps for both iPhone and Android users to

assist with SS HERA selection. Users may select the right product using physical parameters and by entering a competitive worm gear model number. The product search and 3D configurator are user-friendly, quick to navigate, and provide native CAD files.

### For more information:

Regal Beloit Corporation  
Phone: (630) 364-8800  
[RegalBeloit.com](http://RegalBeloit.com)



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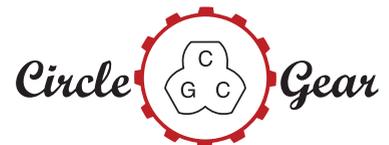
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# Tolomatic

## SERVOWELD ACTUATORS DELIVER COMPACT FOOTPRINT

The latest generation of Tolomatic high-force actuators for seventh-axis robotic spot-welding is now designed on a compact footprint in Tolomatic's most power-dense actuator for weld-gun designs. Compact ServoWeld actuators, available in two patent-pending models, are designed for automotive body-in-white resistance spot welding as well as high-production sheet-metal

welding applications. The compact servo motor and high-force actuator combo can deliver up to 30 million welds (CSWX model) in typical robotic welding applications along with increased force and speed capabilities.

Force range and speed easily adapt to increases in production demand. The Compact ServoWeld CSWX, for both steel and aluminum weld



applications, features Tolomatic's specially designed roller nut to handle 95+ percent of welding applications with C, X, and pinch weld guns. The CSWX can provide up to 18kN of pressing force (4,047 lbf.) in a compact 90 mm frame. Top-speed C-gun performance is 10.5 kN of force (2,023 lbf.) and 700 mm/sec (27.5 in/sec). Options include integrated force feedback, manual override, and long stroke.

"The Compact ServoWeld continues to use Tolomatic's best-in-class skewed winding technology to provide industry leading consistent force repeatability," said Andy Zasko, vice president, sales and marketing, Tolomatic.

Model CSW is designed for lower force (15.6 kN [3,500 lbf.]) and lower duty cycle applications (20 million+ welds) for C, X, and pinch weld guns. Top speed C-gun performance is 7.9 kN (1,641 lbf.) and 700 mm/sec (27.5 in/sec).

Both models include mid-trunnion mounting to easily adapt to a variety of mounting locations, four standard stroke lengths, and force repeatability of plus or minus three percent for the life of the actuator. Integrated anti-rotate and integrated water-cooling options are available.

Tolomatic ServoWeld actuators, validated and specified at the largest global OEMs, are known for superior tip-dressing performance and exceptional sensitivity during robot equalization.

### For more information:

Tolomatic  
Phone: (763) 478-8000  
[www.tolomatic.com](http://www.tolomatic.com)



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## Harmonic Drive

### RELEASES ULTRA-LIGHTWEIGHT GEARHEAD

The CSF-ULW gearhead series from Harmonic Drive features a newly engineered lightweight structure with an ultra-compact shape. The CSF-ULW is a housed zero backlash Harmonic Drive component gearset combined with a precision cross roller output bearing and flange. The CSF-ULW is available in two sizes, with three reduction ratio's per size. The ULW series maintains the same performance standards as the popular CSF-2UH series. Ideal for use on end of arm axes for small industrial and collaborative robots, the CSF-ULW is also well suited for general industrial machinery where weight is a critical factor.

#### For more information:

Electromate (Harmonic Drive)  
Phone: (877) 737-8698  
[www.electromate.com](http://www.electromate.com)



## Goodyear

### INTRODUCES LINE OF BRAKING COMPONENTS

In a licensing deal with FDP Virginia, Goodyear Brakes announced that it is introducing a full line of braking components. Goodyear Brakes was created to address a critical need in the automotive aftermarket for a trusted brand of high-quality brake pads and bundles which are backed by a national warranty, decades of production experience and one of the best-known names in automotive excellence.

“There is a tremendous opportunity for a trusted brand of braking components in the market today,” said Wally McCarty, senior vice president of business development for Goodyear Brakes. “While OEM braking systems have improved and advanced, driver assistance systems (ADAS) have reduced extreme brake wear and increased the brakes’ lifespan. There are very few well-known brand names in the brake category, so this makes it difficult for consumers to determine what are premium quality brake system components

and fair prices when replacing brakes on their vehicle.”

Goodyear Brakes strives to help ensure that drivers are selecting the safest solution for their vehicle. Premium quality brake bundles, calipers, rotors, brake pads and all the hardware for today’s most popular vehicles, from daily drivers to SUVs as well as light trucks are manufactured by Goodyear Brakes. The product lineup offers the ideal solution for almost every braking need – whether drivers are looking to save money on their vehicle repairs, upgrade their performance or restore their perfect car.

“The Goodyear Brakes mission is to provide the most trusted brand of braking components that make your vehicle as safe as possible,” noted Bob Bouwma, director of engineering and advanced technologies for Goodyear Brakes. “Our team of engineers and scientists work every day to improve the quality, performance and durability of each set of brakes

we provide. Using the most advanced technology available in friction science today, the brake bundles are designed to be safe, quiet and long lasting.”

Goodyear Brakes will be sold through [www.GoodyearBrakes.com](http://www.GoodyearBrakes.com) on Amazon and CARid. The portal is designed to give consumers a direct channel to identify their braking system needs using their VIN and license plate information, then order all of the components online. The website also provides expert advice, “How To” videos and proper guidance for brake maintenance and replacement projects.

Aftermarket demand for brake systems and components in North America is forecast to advance 2.6% per annum through 2021 to \$4.3 billion, according to the Freedonia Group research. More than 90 percent of the brake pad market is private label products.

Goodyear Brakes are offered through a licensing collaboration



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### PGO-FGL SERIES

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with Goodyear, one of the world's most trusted automotive brands. The brake pads are manufactured in the USA using a proprietary green production process by a company with more than 50 years of experience in friction science. The rotors are made to OEM standards by OEM-approved manufacturers around the world. Calipers are remanufactured in North America, and a majority of that manufacturing process has returned to the United States, bringing important manufacturing jobs back to the American economy.

The Goodyear Brakes product line was developed through decades of friction science experience, advanced engineering and thorough laboratory and on-road testing. Testing was performed at the company's labs in Virginia, and third-party testing was conducted by Link Engineering Company (LINK) in Detroit. Testing included Dynamometer Tests, Independent Laboratory Tests, Environmental Tests and Certification, Analytical Tests, Vehicle Traffic Tests and Performance Vehicle Tests.

Goodyear Brakes braking systems offer superior braking performance and consistent braking through all temperature ranges, as well as excellent corrosion prevention through its proprietary Antiox Max coating for maximum rust and corrosion protection. This is a critical protection needed for driving in inclement weather and brine-treated streets.

The full product line includes:

- Goodyear Brakes premium brake pads manufactured in the USA and specifically formulated to provide maximum stopping effectiveness, control and durability.



- High-performance Goodyear Brakes rotors that are CNC-machined to build maximum performance, durability and safety into every rotor and feature a proprietary Antiox Max coating for maximum rust and corrosion protection, a critical protection needed for driving in inclement weather and brine-treated streets.
- High-performance Goodyear Brakes calipers that are built using exacting standards to match original equipment manufacturer (OEM) requirements, feature Antiox Max coating and come with the correct brackets and hardware to ensure a perfect installation. Goodyear Brakes calipers are remanufactured in North America, and a majority

of that manufacturing process has returned to the United States, bringing important manufacturing jobs back to the American economy.

- Goodyear Brakes hardware accompanies every brake bundle to ensure you have all of the high-quality parts to successfully complete your brake installation.

**For more information:**

Goodyear  
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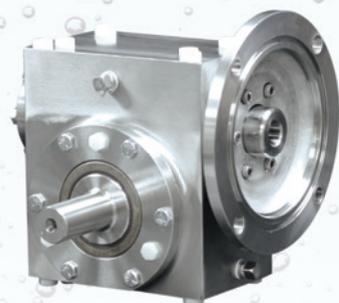


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PRESENTS EVOX PLATFORM

Bonfiglioli, announces the launch of the new helical in-Line geared motor under the newly born EVOX Platform.

Efficiency, reliability, modularity and performance were the drivers behind the development of the EVOX geared motor platform. Thanks to an enhanced modularity concept, EVOX represents a step forward for Bonfiglioli's product range, with solutions for a wide spectrum of applications. The uncompromised selection of commercial components, the broad use of gear grinding processes, and specific "low noise" gear design make EVOX a benchmark product in terms of reliability and efficiency.

The first products of the EVOX geared motor platform are the new Helical In-Line Gearmotor CP combined with the new Asynchronous IE3/NEMA premium high efficiency electric motors.

The synergies between these two new concepts create an efficient, strong, small and simple gearmotor ecosystem. The in-line gear units will be first released in 6 different sizes: 55, 100, 200, 335, 500, 650 Nm with motor power between 0.12 and 15 kW IE3.

The EVOX Platform is characterized by a new simple and clean design, suitable for any application environment furtherly featured by optional C3/C4 surface protection or by ATEX rating (explosion proof protection).

The EVOX CP gear unit is ideal also for higher precision demanding applications, thanks to the reduced backlash configuration available in the standard catalogue. EVOX CP also helps eliminate any customer experienced friction, thanks to an innovative lubrication concept that allows the gearmotor to be

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The geared motors will be available both in compact and IEC flanged versions, allowing customers to choose between a standardized motor and a dimensionally optimized configuration. BXN motor, the IEC standard, and MXN motor, the compact version, share most of the configuration and options, including dynamic brake, incremental and absolute encoders, thermal sensors and switches. The new standard motor terminal box is shaped with its 9 PIN connectors, for up to 8 different voltages at 50Hz or 60Hz power supply with a single winding, making it suitable for the EU, US, Indian and Australian market. Further 6 windings cover the rest of the world.

Bonfiglioli's research and development team designed the entire EVOX platform to enable condition



monitoring and predictive maintenance, both sensed and sensorless. During the development of the EVOX CP gearmotor, a complete mathematical model relating thermal behaviors of the gearmotors to the electrical variables has been developed. This will enable effective sensorless condition monitoring and predictive maintenance directly managed by our AxiaVert

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Haydon Kerk Pittman, a business unit of AMETEK Advanced Motion Solutions division, is pleased to announce the release of the new MiniSlide MSA series.

Today more than ever, lab equipment and automation designers must fit sophisticated motion control solutions into compact spaces. These device makers need solutions that are uniquely suited for their application while being economically priced. The MiniSlide can solve these demanding challenges while reducing the time, cost, and performance concerns associated with developing guided linear assemblies from individual components. The MiniSlide assemblies are highly configurable, simple to integrate, and offer a compact low profile with a stable platform, all at an economical price point. The MSA series is small in size, but big in power!

The MiniSlide series offers tremendous design flexibility with two motor options: a 21 mm, size 8 hybrid linear actuator, and a 20 mm, 19000 series can stack linear actuator. In addition, there are

nine different lead screw options ranging from ~0.3mm to 8 mm – providing resolution down to 0.001524 mm (0.00006 inches) per step, axial forces up to 45N and accommodating stroke lengths of up to 150 mm. Finally, four different lubrication options, a rotary encoder feedback option, as well as English or metric mounting hardware standards are available.

The MiniSlide series provides pre-engineered versatility for a variety of single and multi-axis applications. By providing a compact, cost effective, and highly customizable linear motion solution, the MSA is ideally suited for use in lab equipment applications such as sample handling, spectrometers and chromatographers, molecular analyzers, optical microscopes, and other inspection equipment.

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The project has now reached a relevant milestone, with all the key figures announced at the beginning of the prototype run having been realized for the customer since the start of the project. BeltGenius ERIC analyzes and compares on the basis of standardized values how respective belt conveyor systems of a mine perform. By means of these key figures, Voith is able to identify physical deviations of the belt system, which serve as an early indicator

of failures. In addition, the mine operator is given a starting point for determining how efficiently the respective system transports material. With the help of this key figure, conveyors can be compared with each other.

In this case, the newly defined data made it possible to take measures that led to improved uptime and reduced energy consumption. The prototype is used in a belt conveyor system with a capacity of 37,500 tons per hour and a speed of 7.5 meters per second. The belt of the system is 2.2 kilometers long and 2.7 meters wide and is completely digitally mapped by the system.

“BeltGenius ERIC has achieved all planned key figures at the customer’s site,” says Dr. Manfred Ziegler, business development manager of belt conveyor systems at Voith. “The exact image of the belt conveyor system generated by the digital twin enables us to create



further added value for our customers and thus maximize productivity.”

Voith BeltGenius is the product family used for monitoring, benchmarking and optimizing belt conveyors and conveyor systems. BeltGenius ERIC is a digital twin of the conveyor belt. It processes sensor data in real time to calculate the Performance Indicator of the respective conveyor belt and to point out possibilities for performance improvement.

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# Lubrication for Life

## Lubricant Selection is Often Overlooked in the Design Process

Steven Sanchez, P.E., BSA Certified Bearing Specialist, Engineering Manager, AST Bearings and John Wallace, Vice President of Operations, AST Bearings

### Introduction

Lubrication plays a vital role in the performance and life of rolling element bearings, yet its significance is often underestimated. The most important task of the lubricant is to separate parts moving relative to one another (balls or rollers and raceways) in order to minimize friction and prevent wear. A lubricant that is designed for specific operating conditions will provide a load bearing wear protective film. The ideal condition is when this film separates the friction surfaces. In addition to providing this load bearing film, the lubricant should also allow for the dissipation of frictional heat to prevent overheating of the bearing and deterioration of the lubricant. The correct lubricant will also provide protection from corrosion, moisture, and the ingress of contaminants.

Lubricants used in rolling element bearings should have the following characteristics:

- Maintain a stable viscosity over a broad range of temperatures
- Good film strength that can support loads
- Stable structure that provides for long service life
- Non-corrosive and compatible with adjacent components
- Provide a barrier against contaminant and moisture that does not leak out of the bearing

### Types of Lubricants

- **Oils:** Both petroleum based and synthetic oils are available. Examples of synthetic oils are silicone, diesters, PAO's, and fluorinated compounds. Bearings lubricated with oil exhibit less start up and running torque and have higher speed capability. However, because oils are subject to evaporative losses, their service life in a bearing is less than that of grease. Miniature and instrument bearings are often only lubricated once for the life of the bearing, making the choice of lubricant critical. Larger bearings are subject to re-lubrication as part of the machinery maintenance cycle. These bearings are often lubricated via oil recirculation systems that are designed into the machinery or equipment. Key characteristics to consider when selecting an oil include temperature range, viscosity, and evaporative rate.
- **Greases:** Greases consist of a base oil with a thickener added. These thickeners consist primarily of metal soaps (lithium, sodium, aluminum, and calcium), organic (ureas), or inorganic compounds. While these thickeners greatly influence the characteristics of the grease, the lubricating properties of the grease are attributable to its base oil. Additionally, grease can contain additives that improve its performance. Additive types include antioxidant, anticorrosion, anti-wear, fillers, fortifiers, and extreme pressure fortifiers. Temperature range, base oil viscosity, and stiffness or penetration level are key characteristics to consider when selecting a grease. Most greases used in rolling element bearings are NLGI grade 2.
- **Solid Films:** These are non-fluid coatings applied to the friction surfaces to prevent wear. They are used in harsh situations such as extreme temperatures, vacuum,

or radiation where an oil or grease cannot survive and are typically selected as a last resort, or option. These coatings include graphite, MoS<sub>2</sub>, silver, gold, or PTFE. Hard coatings include TiC or chrome. Solid films are engineered on a specific application-by-application basis.

The lubricant selected and amount used also impact the maximum operating speed and torque, both starting and running. In miniature bearings, the lubricant can impact the noise level. Filtered greases and oils are recommended for use with miniature or instrument bearings.

### Selection Factors to Consider

Lubrication is one of the most critical specifications for the designer to consider. When selecting a lubricant, factors including temperature, loads, speed, environment, and desired life need to be examined. Additionally, there are many characteristics of greases and oils that should be considered such as oil separation, evaporative loss, dropping point, oxidation stability, channeling capability/stiffness, and others.

Grease is by far the most common lubricant selected for the radial ball bearings used in electric motors and gearboxes. Oils provide lower torque characteristics, but are subject to evaporative loss and migration and not always well suited for lifetime lubrication.

### Grease Characteristics:

As previously mentioned, grease lubricants consist of a base oil, mineral or synthetic, combined with a thickener and typically other additives. The properties of a given grease are determined by these components, along with proper handling, storage of the raw materials, and good process control by the grease manufacturer.

### Type of Base Oil:

Base oil viscosity is of primary consideration when evaluating a potential grease lubricant. Viscosity, the measure of "flow-ability", is the resistance to flow caused by internal friction between the lubricant molecules. This characteristic determines load carrying capacity, film thickness, and operating temperature. The higher the viscosity, the higher the film strength. Viscosity varies as a function of temperature. The higher the temperature, the lower the viscosity. Therefore, it is very important to select lubricants based on temperature ranges in operation. Specialty high temp greases, specialty low temp greases, and greases with very wide temperature ranges are available to address specific temperature specifications.

### Stiffness:

Greases are classified by their consistency, or stiffness. The ASTM has developed a test method for determining the stiffness of grease utilizing a cone of a prescribed weight and

dimensions that is dropped into the sample of grease. The cone is withdrawn after 5 seconds and the depth of penetration is measured in tenths of a millimeter. The higher the number, the deeper the penetration and the softer the grease. The grease sample is then placed in a machine that strokes it (think of a mixer or egg beater for baking) to simulate operating conditions. It is then retested. This result is referred to as the worked penetration and is the basis for classification. The National Lubricating Grease Institute (NLGI) classifications are listed in the following table.

Classification of Greases by NLGI Consistency Numbers	
NLGI NUMBER	ASTM WORKED PENETRATION
000	445–475
00	400–430
0	355–385
1	310–340
2	265–295
3	220–250
4	175–205
5	130–160
6	85–115

The lower the NLGI number, the softer the grease. The lower the ASTM number, the stiffer the grease.

### Thickeners

Greases consist of a solid soap such as calcium or lithium soap. In some cases, a fine clay is used that forms a structure in which base oil is held and dispersed. The thickener structure does not provide actual lubrication, but is a reservoir that releases lubricant to the contact area.

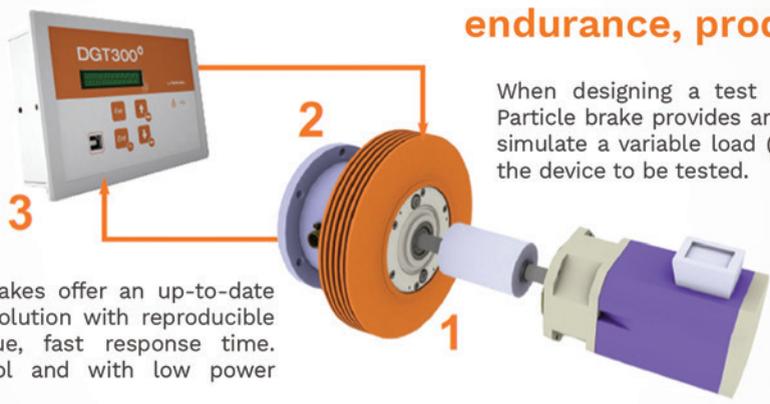
Thickeners, while not contributing much toward lubrication, impart unique properties to the grease affecting its applicability in certain applications or environments. Of these the lithium and lithium complex thickened greases are the most common.

- Lithium — Most common, easy to manufacture, easy to store, good pumpability, flowability permits dirt to flow out
- Calcium — Good water resistance, calcium soap aids lubrication
- Aluminum — Highest resistance to water, chemicals, acids
- Barium — High water resistance, but somewhat toxic
- Sodium — Fibrous, water-soluble

Another class of thickeners is the non-soap thickeners. These are often used in applications where high temperatures are causing other types of thickeners to experience thermal degradation. The organic polyurea thickener offers temperature range limits similar to the metal soaps, but also has antioxidation and antiwear properties that come from the thickener itself.

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- Clays and Silica (Insoluble powders, silica or platelets of clay) — Chemically modified structures and surfaces are made usable as gelling agents for grease. These greases further increase the maximum usable temperature.
- Polyurea — Polyurea greases are called high performance greases due to their broad range of performance attributes.

**Additives**

Greases can be fortified to contain boundary and EP additives, as well as solid lubricants such as graphite and molybdenum disulfide.

- Corrosion and Rust Inhibitors — These are very common additives that prevent corrosion and rusting of metal parts in contact with the lubricant. These additives work by neutralizing acids and forming a chemical protective barrier to repel moisture from metal surfaces.
- Anti-wear (EP) — Anti-wear additives and/or extreme pressure additives are chemical additives that protect metal surfaces during boundary lubrication. They form a protective film on the wear surfaces and react chemically with metal surfaces to form a sacrificial surface film. They are activated at high loads and high contact temperatures.
- Anti-oxidants: Anti-oxidants are found in most greases and oils. They prolong the life of the base oil. Oxidation attacks the base oil. While oxidation occurs at all temperatures all of the time, it accelerates as the temperature increases and in the presence of water, wear metals, and other contaminants.
- Viscosity Index (VI): These additives reduce the rate of change of viscosity with temperature.
- Pour Point: Pour Point additives improve low temperature operating range.
- Tackifiers: These additives help the lubricant adhere to the metal surface during rotational movement.

**Other Considerations**

- Amount: The lubricant amount selected also impacts the maximum operating speed and torque, both starting and running. Too much grease will often cause a bearing to run hot. Generally, as rotational speed increases the fill amount is reduced. Also, as loads increase, the fill amount is normally increased as well.
- Cleanliness: In miniature, or smaller, bearings the lubricant can impact the noise level. Filtered greases and oils are recommended for use with miniature or instrument bearings. Particle sizes larger than the lubricant film thickness will also lead to EHD film breakdown and generate wear debris. This can trigger a progressive process that leads to premature failure.



Figure 1 Diagram of grease composition (oil, thickener additive).

**Shelf Life**

Shelf life is the period following the lubricant’s manufacture during which it is deemed suitable for use without re-testing its physical characteristics. Synthetic oils are inherently stable materials. Generally, they are not expected to oxidize, polymerize or volatilize at room temperature for 10 years or more. Ester oils, where the ester linkage may be subject to a minute degree of hydrolysis in the presence of moisture, could become more acidic if moisture is present. Fluorinated oils and silicones are not likely to be affected by simple aging.

Greases can “age” in more complicated ways. Grease quality could be affected by a change in the gel structure. If the gel contracts, significant oil bleed would be evident and the remaining grease would stiffen. The gel structure may also become softer over a period of time.

High quality lubricants are essential to ensure optimum bearing performance and many are qualified to military or other specifications. When the designer does not specify the type and quantity of lubricant, bearings are lubricated to conform to industry standards.

Manufacturers state that the shelf life applies only if oils and greases are properly stored in their original, unopened containers.

**Lubrication Regimes**

The thickness of the fluid film determines the lubrication regime, or the type of lubrication. The basic regimes of fluid film lubrication are:

- Hydrodynamic Lubrication — Two surfaces are separated by a fluid film.
- Elasto-Hydrodynamic Lubrication (EHL) — Two surfaces are separated by a very thin fluid film.
- Mixed Lubrication — Two surfaces are partly separated, partly in contact.
- Boundary Lubrication — Two surfaces mostly are in contact with each other even though a fluid is present.

In addition to fluid film lubrication, there is solid film lubrication, in which a thin solid film separates two surfaces.

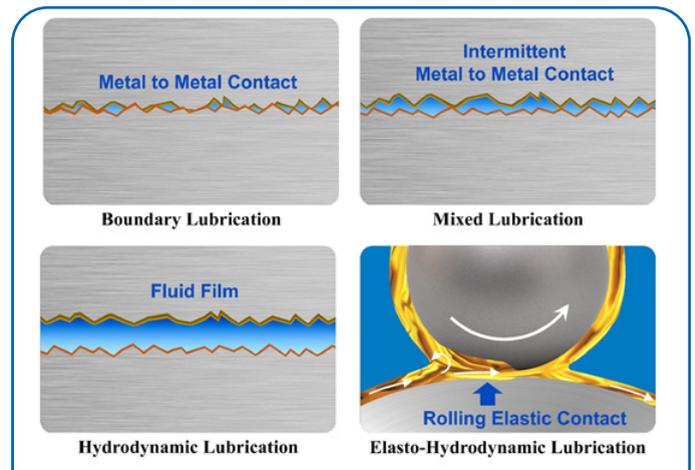
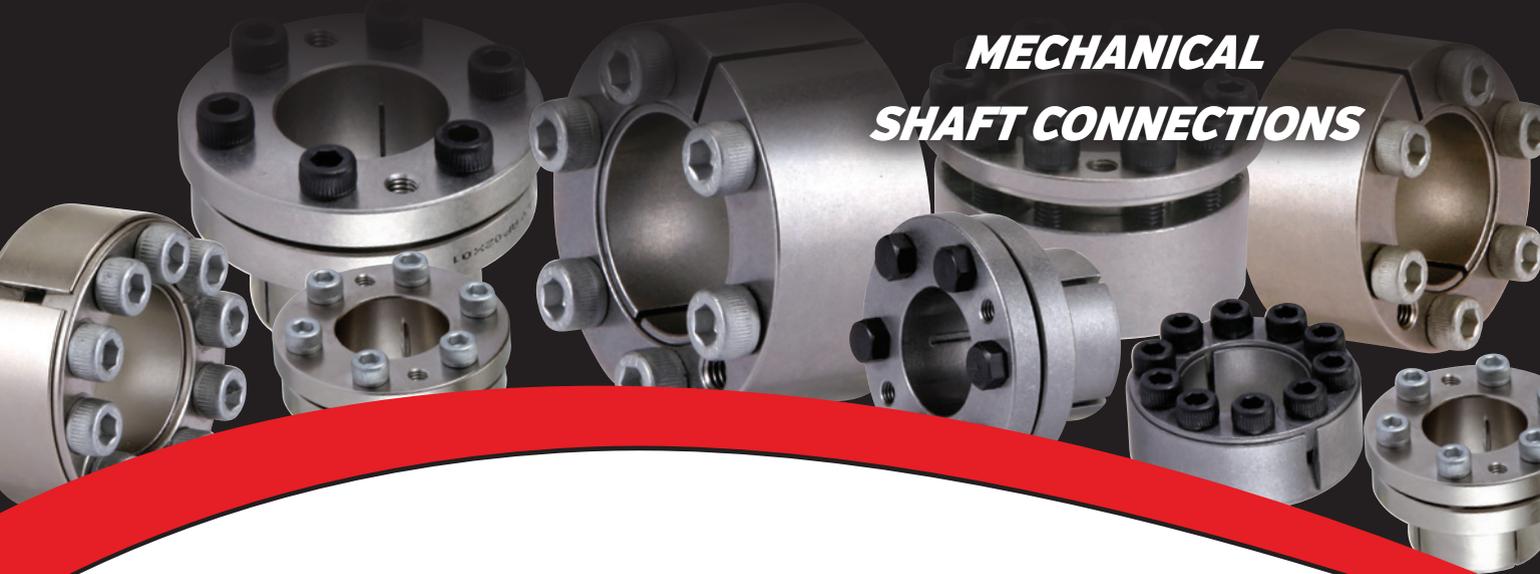


Figure 2 Diagram of the lubrication regimes.

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## Lubricating Film: A Must for Long Life in Ball Bearings

Long bearing life is predicated upon proper lubrication—a lubricating film present and separating the metal surfaces. In the case of radial ball bearings operating in electric motors or other devices running at similar speeds, proper lubrication means the presence of an EHD (Elastohydrodynamic) film. Bearing life calculations assume the presence of this film.

The ABMA (American Bearing Manufacturers Association) standard 9 is used to calculate the basic rating life for ball bearings. The method includes adjustment factors for reliability, special bearing properties, and operating conditions. The adjustment factor  $a_3$  would be used for operating conditions and would be less than 1 if the kinematic viscosity of the lubricant drops below 13 cSt or if the rotational speed is very slow (meaning no EHD film formation). The adjusted rating life could be 20% to 50% that of the basic rating life calculated.

### Film Formation and the Stribeck Curve

The fluid viscosity, the load that is carried by the two surfaces, and the speed that the two surfaces move relative to each other all combine to determine the thickness of the fluid film. This, in turn, determines the lubrication regime. How these factors all affect the friction losses and how they correspond to the different regimes is shown on the Stribeck curve. Engineers use this tool to evaluate lubricants, to design bearings and to understand lubrication regimes (Fig. 3).

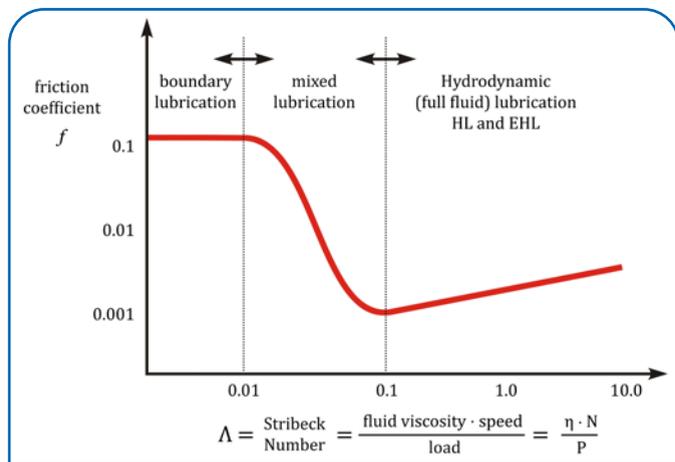


Figure 3 Diagram of a Stribeck curve.

The combination of low fluid viscosity, low speed, and high load will produce boundary lubrication. Boundary lubrication is characterized by little fluid in the interface and large surface contact. We can see on the Stribeck curve that this results in very high friction (Fig. 4).

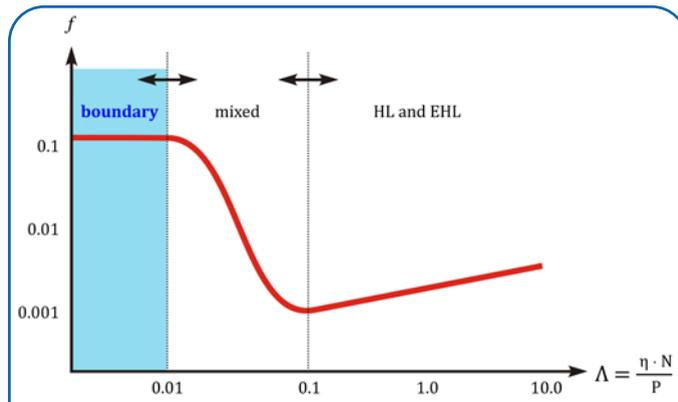


Figure 4 Diagram of a "boundary" Stribeck curve.

As the fluid viscosity and speed increase, and/or as the load decreases, the surfaces will begin to separate, and a fluid film begins to form. The film is still very thin, but acts to support more and more of the load. Mixed lubrication is the result, and is easily seen on the Stribeck curve as a sharp drop in friction coefficient. The drop in friction is a result of decreasing surface contact and more fluid lubrication (Fig. 5).

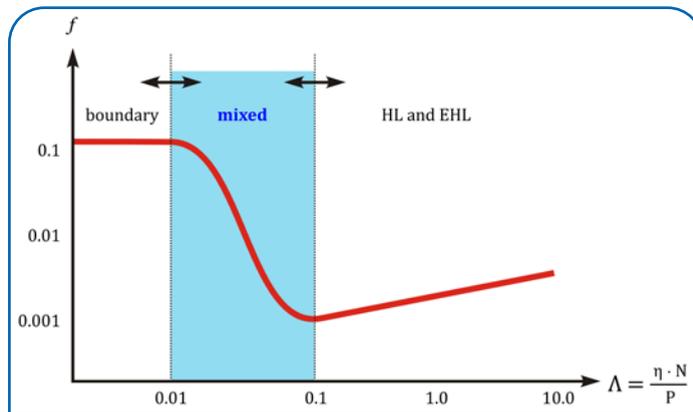


Figure 5 Diagram of a "mixed" Stribeck curve.

The surfaces will continue to separate as the speed or viscosity increase until there is a full fluid film and no surface contact. The friction coefficient will reach its minimum and there is a transition to hydrodynamic lubrication. At this point, the load on the interface is entirely supported by the fluid film. There is low friction and no wear in hydrodynamic lubrication since there is a full fluid film and no solid-solid contact (Fig. 6).

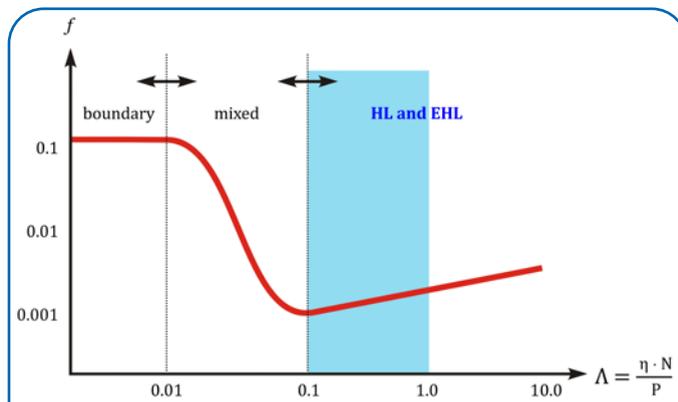


Figure 6 Diagram of a "hydrodynamic" Stribeck curve.

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The Stribeck curve shows the friction increasing in the hydrodynamic region. This is due to fluid drag (friction produced by the fluid)—higher speed may result in thicker fluid film, but it also increases the fluid drag on the moving surfaces. Also, a higher viscosity will increase the fluid film thickness, but it will also increase the drag.

Machinery will typically see boundary lubrication at start-up and shutdown (low speeds and thin film), before transition to hydrodynamic lubrication at normal operating conditions (high speeds and thick film). A review of the Stribeck curve shows us that a motor or machine sees the most friction and wear during start-up and shutdown (Fig. 7).

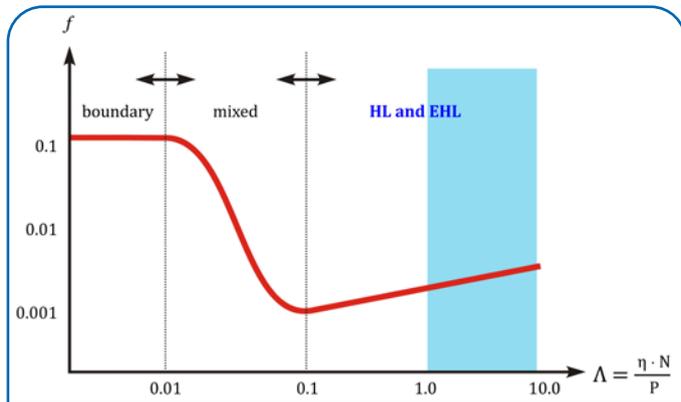


Figure 7 Diagram of an "EHL" Stribeck curve.

Hydrodynamic lubrication gets its name because the fluid film is produced by relative motion of the solid surfaces and the fluid pressure increases that result. The surfaces will have tiny asperities (peaks) and direct contact should be avoided. If one surface slides over the other, then friction increases, the asperities would break off and the surfaces will wear. In hydrodynamic lubrication, the fluid film separates the surfaces, preventing wear and reducing friction.

The hydrodynamic film is formed when the geometry, surface motion, and fluid viscosity combine to increase the fluid pressure enough to support the load. The increased pressure forces the surfaces apart and prevents surface contact. Therefore, in hydrodynamic lubrication, one surface floats over the other surface. The increase in fluid pressure that forces the surfaces apart is hydrodynamic lift.

### Examples of Applications

Typical environments include factory and industrial sites, dirt and contaminants, humidity, and wash down areas. Typical properties of a grease that is suitable for the majority of motor applications:

- NLGI Grade 2
- Mineral or Synthetic base oil
- Thickener formulation that provides durability against mechanical shear forces
- Low noise properties
- Corrosion resistance
- Operating Temperature Range of around -20°F to +350°F

**High speed operation**—The DN value, bearing bore diameter in mm × rpm, can be used to determine if the bearing is operating at high speed. DN values over 1.5 million

warrant a high speed lubricant. Or, a safe rule of thumb is—if the bearing operates at over 70% of permissible speed value listed in the catalog, a lubricant for high speed should be selected. High speed greases typically have base oils with lower kinematic viscosity. At high speeds, higher viscosities lead to excess heat generation. Also, the stiffness of the grease should be considered. A grease that has channeling properties is often desirable. Channeling greases are more easily pushed out of the way by the rolling element as the bearing rotates, and stays out of the way. This results in less churning and less temperature gain. Greases that are non-channeling, or slumping, flow back into the ball path and can result in the generation of excess heat.

**High Temperature**—A high temperature grease should be considered for bearings that continually operate at temperatures above 300-350°F. At higher temperatures the lubricant is subject to thermal degradation. This may be the most challenging situation for lubrication engineers. There are many options that include a variety of base oil and thickener formulations. Oxidation and thermal properties of the grease components—base oil, thickener, additives—must be taken into consideration. However, always remember the base oil is the component of the grease that is primarily responsible for lubrication. The correct base oil viscosity is the factor that determines if there is an EHD film.

**Extreme Environments** can include marine use, salt water, aerospace with exposure to fuel and the hard vacuum of space. In vacuum applications, outgassing is often a consideration. PFPE, or perfluoropolyether, oils and greases are often the solution. They have low vapor pressure and many are formulated with a thickener and additive package that is highly resistant to chemicals. These are often selected for use in aerospace and aviation applications. This family of products can be very expensive.

**Regulatory Environments** such as food processing, medical, and pharmaceutical may require the use of lubricants that have been approved for use applications.

The United States Department of Agriculture (USDA) created the original food-grade designations H1, H2 and H3. The approval of a new lubricant and its registration in one of these categories depends on the list of the ingredients.

**H1** lubricants are food-grade lubricants used in food-processing environments where there is the possibility of incidental food contact.

**H2** lubricants are food-grade lubricants used on equipment and machine parts in locations where there is no possibility of contact.

**H3** lubricants are food-grade lubricants, typically edible oils, used to prevent rust on hooks, trolleys and similar equipment.

Deciding whether there is a possibility of contact is tough, and many have erred on the side of safety with respect to selecting H1 over H2. Since September 30, 1998, the National Sanitation Foundation (NSF) took over for the USDA as the USA organization issuing registration of food-grade lubricants.

## Failure Modes / Improper Selection

Engineers often fail to consider the three important factors of temperature, speed, and loads and don't realize the impact these factors have on the lubricant. If they have not properly analyzed the operating conditions, they can realize too late that they have exceeded the operational characteristics of the grease. Equipment operated in environments the lubricant was not designed for can result in equipment failure, and in an attempt to determine why it failed, the OEM discovers that a different grease will not only have solved the problem but also expand the usefulness of the equipment.

One of the most common mistakes is not knowing that a grease engineered for certain conditions can greatly increase life. Designer simply selects a bearing with a standard factory supplied lubricant. Although these lubricants are a good choice for most applications, they may not be suited for certain environments.

In addition to temperature, speed, and loads, designers must consider other operating factors and environmental conditions that may impact lubricant performance and life. These include oscillatory movement, vibration, and shaft orientation (vertical versus horizontal). Environmental conditions include extreme temperatures, moisture and humidity, or the hard vacuum of space. Water entry and particulate contaminants can also affect the efficacy of the lubricant.

Bearing failure is generally the result of wear from the ball/raceway contacts. If the lubricant fails, the load bearing EHD film that prevents contact between the metal surfaces breaks down. When this happens, the high asperities of the raceways and balls come in contact and break off and metal particles enter the lubricant. As wear progresses, the lubricant becomes a mixture of metal wear particles and degraded lubricant. This leads to deterioration of the components and ultimately bearing failure.

## Summary

Selection of the right lubrication is essential for peak performance and extending the life of rolling element bearings in electric motors and gearboxes. Engineers who consider all the lubrication selection factors discussed here will maximize the life of their bearings and machinery, therefore saving money, time, and manpower and make operations more efficient and more reliable. **PTE**

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**John Wallace** is a degreed Mechanical Engineer with over 30 years of industry experience in Engineering, Manufacturing, and Quality Assurance. He has been Vice President of Operations at AST Bearings since 2003. John can be reached at [jwallace@astbearings.com](mailto:jwallace@astbearings.com).



**Steven Sanchez, P.E.** is a degreed Mechanical Engineer, a licensed Professional Engineer in the State of New Jersey, and a BSA Certified Bearing Specialist with over 25 years of industry experience in Engineering & Manufacturing. He has been the Engineering Manager of AST Bearings since 2013. Steven can be reached at [ssanchez@astbearings.com](mailto:ssanchez@astbearings.com).



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# Sulzer

## Supplies Recirculation Pumps and Offers IoT Analytics for Retrofit

Nordlaks is a Norwegian fully integrated company that produces, processes and sells Atlantic salmon and rainbow trout worldwide. It has recently completed the building of a new smolt facility for fish up to 500 grams at Innhavet in Hamarøy municipality. This RAS (Recirculating Aquaculture System) fish farm is the biggest of its kind in Norway, with a special focus on smolt welfare. The land-based facility has state-of-the-art equipment for optimal biosecurity and sustainability. At the heart of the RAS process, all recirculation pumps were supplied by Sulzer.



New Nordlaks fish farm in Innhavet, Norway.

### The challenge

The Innhavet RAS plant has 34 fish tanks of different capacities (350 to 1'000 m<sup>3</sup>) in 5 separate main sections. Each section is independent from the others and includes its own complete water treatment system in a semi-closed loop (98% recirculation + 2% make-up water). The brackish water from the fish tanks first flows by gravity to a rotating drum filter for the removal of the main suspended solid particles. It then falls into an MBBR (Moving Bed Biofilm Reactor) for TAN (Total Ammonium Nitrogen) reduction. After passing through a countercurrent degasser for the stripping of nitrogen and carbon dioxide, the treated water is finally pumped to some head tanks, prior to oxygenation and return to the fish tanks.

In each fish tank, the water is fully renewed every half an hour. The well-being of the smolts is highly dependent on a constant flow of water through the facility. The reliability of the recirculation pumps is, therefore, of paramount importance.

High overall energy performance of the RAS plant means a better environmental footprint and reduced operating costs. Consequently, the main components of the water treatment loops must have top-class efficiencies, particularly the recirculation pumps.

### The solution

As a long-term supplier of equipment (pumps and turbines) to other Nordlaks plants, Sulzer was involved at an early stage of the new project. In collaboration with the Momek Group, a large industrial service provider in Scandinavia, the pumps were carefully selected, not only to fulfil the requirements during the warranty period, but to run optimally and economically during the whole lifetime of the site. For the recirculation of the brackish water, 50 AHLSTAR and BE process pumps in duplex material have now been installed and are operating continuously. In addition, 5 VUPX submersible propeller pumps are used on intermittent duty when the fish tanks are emptied during the transfer of smolts.

### Customer benefit

By choosing to work with a trusted partner, the client made sure to get fast and



Five AHLSTAR A43-500 recirculation pumping units for brackish water.

permanent technical support, in addition to the best products. The recirculation pumps have the following major advantages:

Extremely high hydraulic efficiencies that by far exceed the strictest energy regulations for water pumps. This means huge energy savings over time and smaller total cost of ownership.

Duty points close to BEP (Best Efficiency Points), low rotation speeds and rigid baseplates grouted in concrete. The pump units are working smoothly with minimized vibration levels.

Superior-grade material for all wetted parts. For the choice of pump material in contact with brackish water, the long-term perspective favored duplex stainless steel rather than 316SS. Duplex steels have better design strength than austenitic stainless steels, as well as higher corrosion, abrasion and pitting resistance. In the end, maintenance costs and the risk of downtime are reduced.

### Sulzer Utilizes Pump Analytics to Optimize Retrofit Solutions

For those in the energy industry, being able to identify pre-failure conditions and anomalous operation can offer a considerable advantage to a repeatable budget and bottom-line margins. Using this intelligence to permanently remove failure modes through retrofit solutions will further extend the service life of rotating equipment.

Seth Tate, technical advisor with Sulzer, looks at how a cutting-edge software solution can analyze existing pump telemetry to reduce downtime and justify engineering improvements.

Around the world, operators of high-energy pumps are well aware of the high running costs and therefore looking for effective and reliable strategies to reduce them. Implementing pro-active maintenance strategies is well-known to have a positive effect on downtime. Now it is possible to use data from existing sources to provide intelligence that will allow system availability and reliability to be improved.

### Cost of downtime

The reduction in maintenance costs and equipment repair time are directly linked to corrective maintenance strategies, such as preventative maintenance, discrete predictive maintenance or online predictive maintenance. As the techniques to identify pre-failure conditions become more sophisticated, it is possible to perform the right maintenance task at the most opportune time. In addition, the insight provided can also be used to justify retrofit solutions.

These extend the normal operating conditions of high value assets. At the same time, predictive maintenance strategies can leverage existing data sources and maximize their efficiency by applying big data analysis principles.



Five BE325-2532 recirculation pumps offer a huge energy savings and smaller total cost of ownership.

This enables operators to achieve maximum availability and throughput and when high-value commodities are involved, this can amount to a lost profit opportunity (LPO) of USD 200'000 per day.

In terms of performance and efficiency, a 4'000 hp (3'000 kW) pump operating at 43% of its best efficiency point (BEP) flowrate will present an LPO of approximately USD 300'000 per year. Looking at how reliability affects outcome, chronic seal failures in high-energy equipment can cost USD 18'000 per occurrence but including lost production can see costs rise to USD 144'000 per failure.

Therefore, being able to implement remedial actions during planned maintenance periods before component failure occurs as well as understanding the root cause of an issue can deliver considerable value for the business.

### Pump data acquisition

In order to translate equipment performance data into actionable intelligence, the related sensors as well as a conduit between the sensors and software must exist. Many pumping systems already have the necessary resources to satisfy data acquisition needs. The historical performance data that is already being stored can provide insights that are essential for the active monitoring process. By making better use of this stored data, it is possible to accelerate the journey to realizing value.

### Advanced pump analytics

By developing a software solution that integrates with existing data platforms, the opportunity already exists to conduct big data analyses. Equipment that is designed using advanced physics can be monitored under the same principles. Sulzer's solution, known as BLUE BOX™, creates a prediction map of equipment operation using both Sulzer's expertise in failure mode and effects analysis (FMEA) modeling and machine learning intelligence.

What if operators were informed that equipment is running

below minimum continuous stable flow? What advantage is there to knowing that a bearing is failing?

Using the gathered data, this advanced analytics approach goes beyond just a digital twin to detect pre-failure conditions and optimization opportunities. Key to the added value are an out-of-the-box readiness, false positive prevention, advanced physics and an operational dashboard.

At the same time as identifying future maintenance interventions, there is a requirement to derive the most effective solution and justify the cost in terms of lost performance or downtime that can be saved. This enables engineering managers to assess potential solutions and provide a cost analysis, all before the predicted issue has an impact on production.

### Retrofit to improve existing assets

Having identified the issue, retrofit solutions can be used to permanently remove causes of failure through improved engineering, design, maintenance or operation. The best course of action can be identified through gap analysis – comparing the current solution, which is experiencing reliability issues, to the best-in-class design. Today, the latest engineering technology can do more than just remove specific failure causes on legacy equipment.

In addition, retrofits can be implemented to address new or updated hydraulic needs. Having identified the performance topography, a new hydraulic profile can be manufactured without disturbing the footprint of the pump installation by applying computational fluid dynamics (CFD) and an original equipment manufacturer's (OEM's) considerable hydraulic experience.

### Total cost of ownership

In a world where downtime can be measured in hundreds of thousands of dollars per day, even modest improvements in availability can have a significant improvement in operat-



A well-organized pump repair workshop reduces downtime and minimizes costs.



Experienced machine tool operators are key to setting up and operating precision equipment for extensive repairs or retrofits.

ing costs. For instance, an improvement of 0.08% in the performance of a high-energy pump will equate to 72 hours per year of uptime that would have otherwise been lost. This can potentially deliver an improved annual income of approximately USD 650'000.

In the example of pump performance, the data analysis solution can illuminate tangible opportunities for effective improvements. In addition, removing the residual effect with off-BEP performance can eliminate failure modes and extend the service life of the pump, promoting uptime and reducing the total cost of ownership (TCO). Putting this into numbers, recovering 32 efficiency points equates to approximately USD 290'000 in running costs.

### Expert pump support

As an original equipment manufacturer (OEM), Sulzer has combined its expertise in pump engineering and extensive experience in pump operation to create BLUE BOX, an advanced analytics solution that can deliver expert insight into any pumping system.

Simple integration, with no additional hardware and a secure interface, BLUE BOX uses existing telemetry and communication protocols to analyze the data. It is designed to grow with future technological changes and provide continuous visualizations through a customized operator dashboard. Now, it is possible to predict the future of maintenance operations and use this information to optimize business performance. **PTE**

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# Belt & Chain Technology

Edited by Matthew Jaster, Senior Editor

The following article examines some of the recent product and industry news items on belts and chains featured on the PTE website—news from Continental, Gates, Igus and Tsubaki. Be sure to check out additional information in our Pack Expo coverage on page 56.

## Continental

### EXPANDS PRODUCTION AND RUBBER-PROCESSING CAPABILITIES

Continental is continuously expanding its production site in the Harburg district of Hamburg, Germany, into a tech campus with a range of business units. Products such as air spring systems that enhance ride comfort on the Hamburger Hochbahn (Hamburg's largest public transport company), the establishment of a new training institute for semi-skilled and unskilled employees, a center for innovation and digitalization and a state-of-the-art center of competence for plastics are examples of this transformation.

“Thanks to continuous investment and a future-oriented approach, the plant has developed from a former rubber processing site to a location where solutions for the mobility of the future both on and off the road are designed and produced,” explains Dr. Peter Scholtissek, who heads the Harburg location.



The company sees itself as a collaborative partner and reliable player in Hamburg's corporate network, whose work is closely linked to Hamburg as a business location and center of science and research, in particular to the knowledge and technology transfer company Tutech, the Hamburg University of Technology (TUHH) and other universities throughout Germany. In this context, the technology company offers students the opportunity to investigate the potential and feasibility of concepts for future-oriented developments and trends together with experts from Continental in what is called the Makers' Garage. These projects enable young engineers and software developers to put theoretical

knowledge into practice, work in international teams and establish contacts with startup companies, thereby also offering them a springboard to starting a career at Continental.

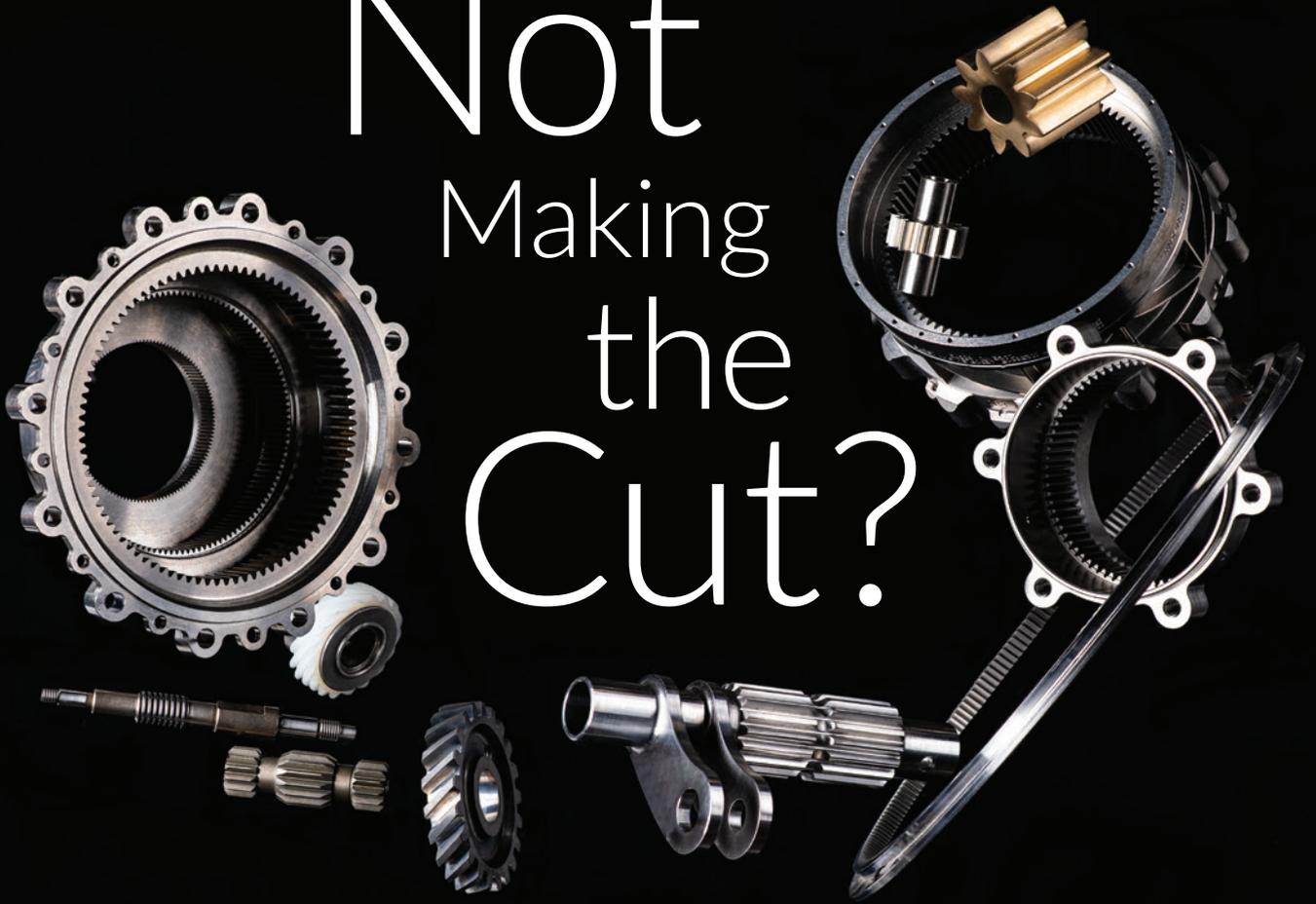
This new area supports Continental's industrial business in the planning and implementation of digital “smart” projects – with a particular focus on applications in the fields of Internet of Things and cloud-based app development. The aim is to develop solutions that add a digital component to the existing range of rubber and plastic-based products, creating the basis for new digital business models. In the future, all global innovation and digitalization activities of the ContiTech business area will be coordinated by the new Innovation Center in Hamburg.

One example of such developments is Fleetmatch, which has also been supported by Continental's Hamburg-based digital experts. This web and app-based solution connects qualified professional drivers and fleet operators and gives drivers a strong voice by enabling them to evaluate loading docks easily and quickly. This means Fleetmatch addresses two challenges of the logistics industry: the shortage of professional drivers on the market and the widespread lack of appreciation for this professional group.

In addition to its newly-created capacities, Continental is investing in further materials-related expertise alongside rubber processing. 2.2 million euro was invested in the Plastics Competence Center in Hamburg-Harburg, where high-performance hose lines for electric vehicles are developed and tested. There is growing demand in the automotive industry for high-performance technical materials such as plastics. Hose lines are required in modern vehicles for thermal management, i.e. the targeted heating and cooling of components such as batteries or electric motors. Efficiency and range can thus be significantly increased. In this function, Continental's Hamburg location is responsible for central product development for all of the company's production plants worldwide.

But the mobility of the future doesn't just mean moving by road: passenger transport by rail will also become increasingly important in the future. The Hamburger Hochbahn's DT5 trains are fitted with air spring systems from Continental. The auxiliary spring, a relevant component of the air spring system, is produced at the Hamburg location – the rubber compound for it is also produced at this traditional hanseatic site. In addition, the spring systems can also be refurbished at the company's own maintenance center at the customer's

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request. A new machine was purchased in 2019 to prepare the metal-rubber elements. It combines multiple production steps into one system and thus increases efficiency and competitiveness.

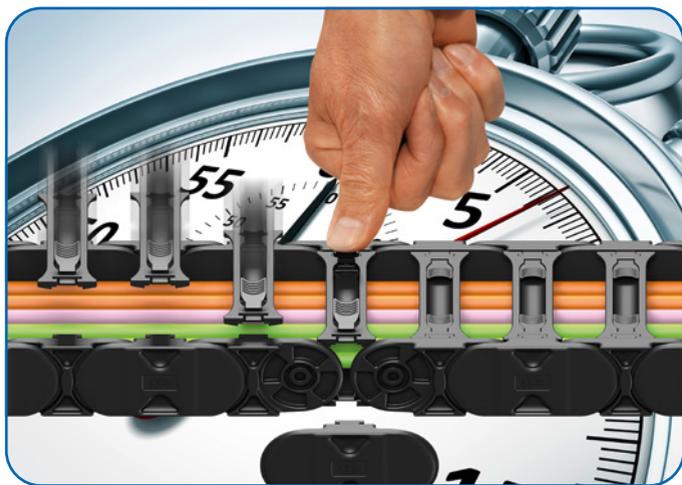
At the Hamburg location, Continental is investing not only in machinery, but also in people: The technology company is offering its semi-skilled and unskilled employees a step-by-step qualification for the state-recognized vocational qualification of process mechanic for plastics and rubber technology. This continuing education and training opportunity from the “Continental Institute of Technology and Transformation” (CITT), founded in 2019, completes the location’s package for employee qualifications, which also includes measures to integrate the long-term unemployed and provide career orientation for young people.

#### For more information:

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## Igus

### INTRODUCES LIGHTWEIGHT E4Q E-CHAIN



Igus recently introduced its E4Q energy chain, which offers a smooth, contoured design and a completely new crossbar concept with weight-reducing locking straps. The new design ensures that the e-chain can be opened and closed in seconds without tools.

The energy chain has been specifically developed for the special requirements of unsupported lengths. High unsupported lengths and long travels with large fill weight create extreme stress on energy chains. The igus developers have designed the E4Q e-chain intended for such application scenarios. Based on the robust energy chain standard E4.1 from igus, the new series brings along a long service life and a high degree of modularity.

In order to optimize material and therefore the weight of the energy chain, shapes inspired by nature are used. The smooth, contoured design can be found on the outside of the chain links as well as on the stop-dogs. Despite material recesses, the new development has a high strength and stability comparable to the E4.1 series.

### Tool-free and quick installation with new crossbars

Another special feature of the E4Q are the crossbars. These can be opened and closed without tools. On the top of the crossbar, there are two hollows for the fingers, by which the locking hooks can be easily pulled up. Unlocked on both sides, the crossbar can be removed with little effort. This allows the easy opening and closing of the chain even in a guide trough and accelerates the filling of the e-chain by up to 40 percent.

Another advantage is the new crossbar has significantly higher pull-out forces than its counterparts in the locked state thanks to its innovative type.

### New optional additional noise dampening

Due to its special design, the e-chain is in movement. However, if the user desires additional noise reduction, igus has integrated an optional system in the inner horizontal stop-dog for the E4Q. These are two connected balls that dampen the impact during the radius and extension stop. The balls are made of a new noise-optimized and soft material that further reduces the sound level without restricting the stability of the stop-dogs.

#### For more information:

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## Tsubaki

### OFFERS NEW CHAIN TECHNOLOGIES

Tsubaki’s latest innovation, the Tsubaki Titan Chain, is designed to offer previously unobtainable wear life in harsh applications, like in abrasive and dusty conditions, such as those found in timber mills, stone sawyers or brickworks.

Created by the company’s global research and development team in Japan, Tsubaki Titan Chain combines the best features of the existing premium GT4 Winner chain with new specifications designed to deliver the ultimate in wear performance.

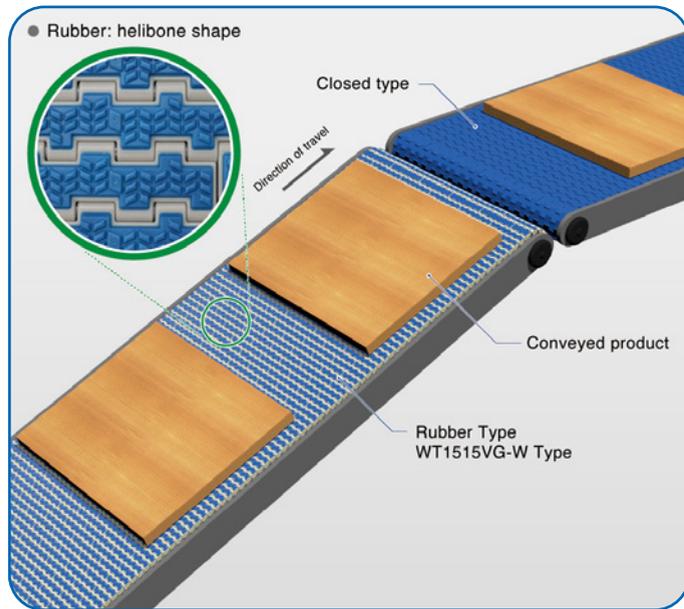


Perhaps the most obvious feature of Tsubaki Titan chain is the use of seamless bushes that incorporate Lube Grooves. The bushes are precision made and perfectly cylindrical, to ensure the smoothest possible operation which in itself will help minimize wear. Enhancing this, the special Lube Grooves ensure oil is retained at the very point of contact — where the chain needs it most. This limits the wear between pin and bush, significantly improving the wear life as a result.

The pins have a special coating that provides an extra hard yet low friction surface, thus helping increase wear life further. As a result of these innovations, maintenance cost and downtime are reduced to a minimum. These factors, plus the reduced frequency of swapping out old chain for new, add up to a significant reduction in the Total Cost of Ownership.

The development team have specified corrosion resistant nickel-plated outer link plates for the Tsubaki Titan Chain, which combined with black oxide inner link plates provide an extra layer of protection against corrosion. Tsubaki has also incorporated its unique process of Ring Coining the connecting links, which ensures that the chain can be specified up to its full load capacity.

As standard, Tsubaki Titan Chain is available in sizes 12B to 32B. Additional sizes, multi-strand and attachment options will be available upon request. It was developed in Japan at the company's Kyotanabe Technical Centre with input from Tsubakimoto Europe B.V. It is seen as part of the Tsubaki Group's commitment to conserve the environment and reduce the impact of its products and operations by helping customers reduce energy consumption and save cost.



In addition, Tsubaki recently released a the WT1510 Series rubber type plastic modular chain. This chain offers suppressing slippage of conveyed products and reliable vertical transportation options. Herringbone-shaped rubber is attached to the surface of the chain by double injection molding. It is a suitable replacement for a belt conveyor.

Compared to WTM2535G-M type (magnet type) and WT1515F-W type (flight type), WT1515VG-W type (rubber type) can transfer conveyed products smoothly to the next process, owing to an inline layout without using transfer plate between conveyors. The chains of their width 50 mm and 100 mm adopt a slit pin with integrated plug system. The series offers easy maintenance and partial repair.

**For more information:**

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# Gates

## OFFERS HIGH-PERFORMANCE BANDED V-BELT

Earlier this year, Gates introduced the world's first wrapped V-Belt technology using Ethylene Elastomer (EE) compounds for original equipment manufacturers (OEMs) in the agriculture, forestry and heavy industrial markets. The launch of the Xtreme V-Force Mega banded V-belt platform leverages Gates' materials science and manufacturing process expertise to produce unique EE-based solutions that provide customers with increased performance and uptime, and extended operating temperatures.



"At Gates, transforming our industrial belt platforms using Ethylene Elastomer compounds is a priority," said Tom Pitstick, CMO and senior vice president of product line management for Gates. "With the development of our PowerGrip GT4 synchronous belts, G-Force RedLine CVT power sports belts and the new Xtreme V-Force EE banded belt family, we are leading the way in advanced materials development in our industry."

The new Gates Xtreme V-Force Mega belt offers a number of benefits vs. currently available products on the market, including:

- An extended operating temperature range from -40°C to 130°C;
- A 30% increase in load capacity and durability, which enables:
- Performance in even more demanding applications;
- The ability to design higher-load drives without increasing the design footprint on today's high-powered equipment
- Improved flex for higher-speed drives;
- The elimination of chlorinated polymers, which improves the overall environmental impact of these products.

Ethylene Elastomers, which involve complex processing technology, help enable a number of the performance advantages of this new belt platform. Gates' continued focus on the intersection of materials science and process engineering is what has enabled the company to bring these and other Ethylene-based products to market. **PTE**

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Established in 1950, SDP/SI designs, manufactures and builds custom subassemblies with world-class quality and reliability for all applications. Completed December 2016, our 96,000 square foot state-of-the-art Hicksville, NY facility houses the latest manufacturing, industrial automation, and inspection equipment. Employing skilled machinists, CNC programmers, inspectors, engineers, and customer service personnel, we meet the highest-quality standards your business deserves.

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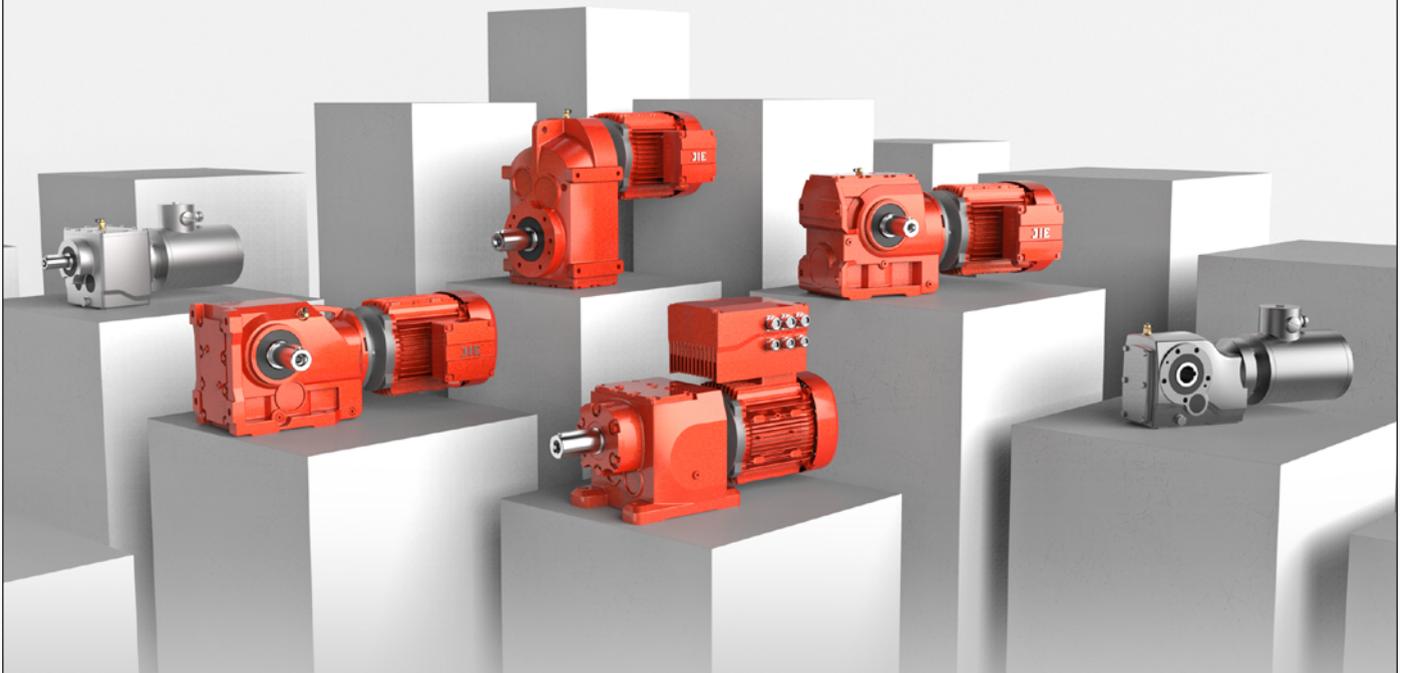


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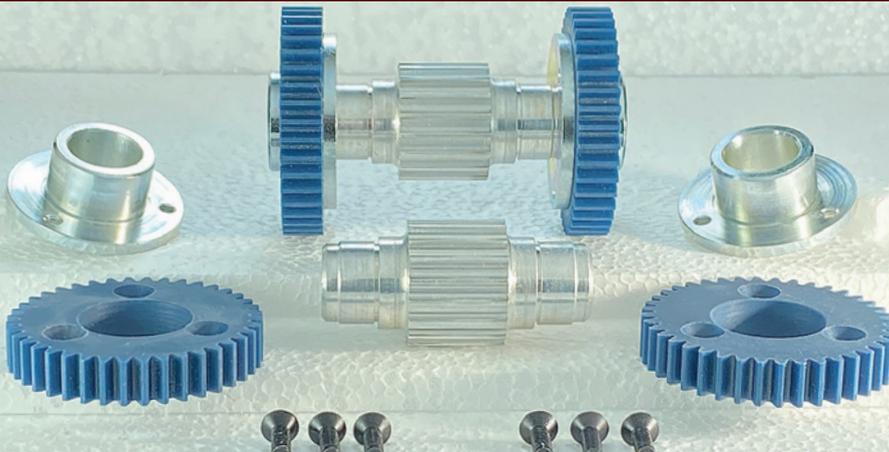


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# Keeping Drives Electrically Quiet: Ferrites, Shielding and Grounding

Donald Labriola, P.E

Motion control systems often combine high power drive signals in close proximity (or even within the same cable) with lower level signals, like encoders. You will often see ferrite beads added around cables; their effectiveness in minimizing noise is greatly affected by how they are deployed. This involves which signals are grouped, what are the drive characteristics, and how shielding and grounding are handled in the system.

Real life magnetic cores are not typically covered in many engineering courses. The idealized magnetic core has a significant complexity involved. Permeability, saturation, coupling, losses, etc. are all significant complexities. Trying to look at these devices over broad ranges of frequencies with exact equations and models turns into a significant exercise. We will start with the basic equations for idealized parts, followed by talk about the departures, and finally rule-of-thumb heuristics.

A ferrite core is commonly placed over a cable in an attempt to reduce noise — both radiated and as it interacts internally to the system, and to reduce the received noise. The ferrite forms a common mode coupled inductor / transformer for each of the signals passing through it. The range of frequencies of the coupling is dependent upon the type of material used in the bead, how many turns are wound, and how the turns are physically wound. The inductance also depends on the physical geometry of the ferrite material.

First, we will begin with the basic textbook equations for the inductance of a wire passing through a core; the inductance can be calculated as:

$$L = \mu N^2 A / 2\pi r$$

Where

$\mu$  = permeability of the core

$N$  = number of turns

$A$  = cross-sectional area of core

$2\pi r$  = mean path length around the core

To change this to word problem format: the inductance goes up with the square of the number of turns, with the permeability of the core and with the cross-section of the core. Inductance goes down with the mean path length (average circumference of the path around the wires).

Using the same material, a thick bead (large area) with a small internal hole (smaller radius  $r$ ) has a significantly higher inductance than a thin ring (small area) with a large hole (large  $r$ ). A few turns can significantly increase the impedance if they can fit through the core. Winding is important to prevent capacitive coupling between the turns from “bypassing” the bead impedance. In general, use the bead with the smallest hole available that will fit the cable.

Reality adjustment: Many of the ferrite beads commonly used for filtering have large resistive losses and are not simple

inductors. However, this is often a good thing as lossy ferrites convert the electrical noise issues into heat; as long as the heating is not excessive, this keeps the noise from just being conducted or radiated elsewhere. An even worse effect is when the noise is resonated, which can significantly increase the effects of the noise. (Note that resonance is used intentionally when trying to radiate RF energy in a radio transmitter!)

There are many different ferrite “recipes” or blends available, targeted for many diverse purposes. The blends used for a high-efficiency switching power supply often would not be the best for use in filtering power cables, for example. According to the frequency of the switcher, the materials and often their processing will also commonly vary. Higher permeability materials allow for significant impedances at lower frequencies but are also more easily saturated in that their permeability drops rapidly as the net current through the aperture of the bead increases.

A simple fix that allows the use of these higher permeability cores while avoiding the saturation is to form common mode inductors where the currents are fairly balanced so that the *sum* of the currents through the wires is fairly low. As only the net current through the core gives rise to the magnetic field in the core, the field is reduced considerably reducing chances of saturation. The coupled inductor that results from passing sets of signals through a ferrite bead can be used in multiple ways to reduce noise issues.

The first example using the bead as a BALUN (Fig. 1) - a contraction of **BAL**anced-**UN**balanced. A Balun configuration can be used to convert balanced signal lines into an unbalanced line or visa versa. The driver to the motor is unbalanced as one half bridge driving the motor switches while the other does not (generally) simultaneously switch in the opposite direction. This is contrasted to an RS-485 which is balanced: the transitions in the two signals are (approximately) equal and opposite.

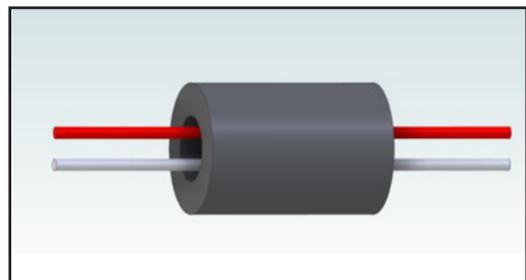


Figure 1 Using a Ferrite bead as a BALUN to match an unbalanced drive circuit to balanced wiring.

We will draw this configuration for a 2-wire system, but the same concept also applies to a 3-phase system. The schematic (Fig. 2) is simplified and depicts the phase that is not switching as being grounded, while the phase that is switching at this time is shown as a pair of transistors. Not shown is the capacitance between the wires, nor from the wires to the surrounding environment, nor the load of the motor windings.

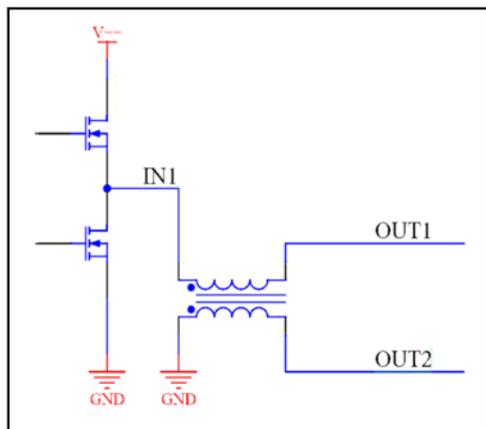


Figure 2 Simplified schematic of a bridge driver showing only the elements about to change state feeding wiring through a balun.

When the signal at IN1 takes a positive step (switching the upper transistor on), a current flows into OUT1 wire to charge the capacitances associated with IN1 wiring. This current causes a positive to negative voltage drop from IN1 to OUT1 due to the rapid change in current interacting with the inductance of the ferrite bead. (That is, the inductance of the bead opposes the rapid change in current through it.) This voltage drop reduces the size of the step at OUT1, as compared to the step size at IN1. This same negative voltage step (from the transformer function of the bead) appears OUT2. If the step is sufficiently fast compared to the bead inductance, the output will be (instantaneously) nearly balanced: OUT1 will step to half of  $V_{++}$ , while OUT2 will go to minus one-half of  $V_{++}$ . The voltage between the two conductors at the output will still be essentially the same as the voltage between the two conductors at the input.

While the average voltage of the two wires at the input jumped to one-half the supply voltage  $V_{++}$ , the average of the wires at the output remained close to zero volts (for the high-frequency components of the waveform immediately following switching). This balancing of the signals by the ferrite bead greatly reduces the coupling to nearby signals, as the high frequency components of the signals from OUT2 nearly cancel those from OUT1. A similar balancing of the currents is also present for high frequencies, reducing the net high frequency components of the H-field (magnetic field) from the pair of wires.

The use of a ferrite is commonly paired with using twisted pairs (or triples for 3 phase). If the signals are fairly well balanced, the average voltage (at high frequencies) will be fairly low. The twists in the wire will alternate which wire - OUT1 or OUT2 is closer to the test wire (victim signal), significantly reducing the noise coupled to it. The magnetic field emissions

are reduced by a similar method: the magnetic field is produced from the small loops from each half of the twist will tend to cancel out the magnetic field from the adjacent loop formed by half of the twist, as the sense of the turn is reversed. Again, this cancellation is improved by having the signals balanced, at least for frequencies of interest.

**But how about the shield?** A shield is often added (Fig. 3) around the driven wires between the driver and the motor to reduce the electric field from the drive wires from radiating. The question always arises as to where and how to ground the power cable shield.

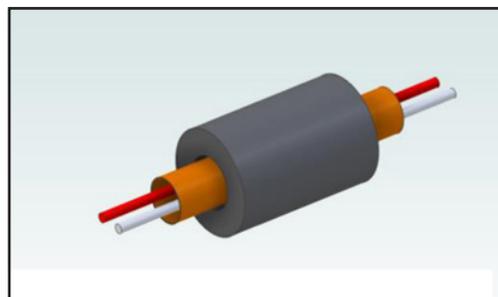


Figure 3 A BALUN for shielded wiring pair (often shielded twisted pair).

We have found that grounding the shield — either directly or through a significant capacitance — at the drive, and also grounding the driver signals shield at the motor significantly reduces the radiated noise from the drive. Note that while the power supply return is often not directly connected to the chassis ground, generally EMI filters are present which add a capacitance from the DC rails to the chassis. This is not shown for simplification, but these return paths for high-frequency signals from the chassis to the power supply rails are still normally present.

The first thought is that this configuration is forming a ground loop through the chassis as the driver and motor are both connected to the chassis, and thus it should be avoided! For feedback signals that do not inject (significant) current into the chassis, this is certainly the case — ground one end of the shield (generally at the controller end of the cable). For the motor, the extra capacitance between the motor windings and the stator changes the situation. A ferrite bead over the whole cable can greatly reduce the currents coupled from the windings to the stator and to the system chassis ground.

Let's first look at what would happen if the shield connection to the motor were not present (Fig. 4). A positive step at IN1 will cause OUT 1 to go positive and OUT2 to go negative, but the extra capacitance of the shield will give an additional current path through the ferrite bead and it will not work as nicely balanced as the previous balun example. The motor windings have a capacitance to the stator of the motor, which is commonly tied to the local chassis. The step in the average voltage to the winding will induce a current through this capacitance into chassis ground when the driver takes a step. The only return path for this current is through the chassis, and so there will be a loop through the cable to the motor, and back through the chassis. The noise will be radiated by the loop formed by the cable and the chassis ground return path.

Now let's see what happens if the chassis is connected at both the driver and to the motor. The ferrite will "attempt" to minimize the net change in current through the bead. In this example, a 100 ohm bead is used, i.e. approximately 100 ohms at 10 MHz. The current from the step on IN1 will cause a small negative voltage on the output side of the shield conductor, such that most of the current capacitively coupled from the windings to the motor stator will be drawn back through the shield.

To greatly simplify: current that passes in one direction through the beads has to pay the 100-ohm toll (bead impedance) to flow, while that current which returns back through the bead does not pay the 100-ohm toll, as the magnetic fields produced by the two (or more) wires will cancel. This makes the return path through the shield going through the ferrite bead the much preferred path.

Actual testing in a system with a hybrid motor showed the current to the chassis without the shield connection was on the order of 1A, with a fast switching driver. The current through the chassis dropped to approximately 20 mA with the shield grounded and a ferrite bead over the whole cable—or about a 35dB improvement! Almost 98% of the current returned via the preferred path. This reduction is most effective at higher frequencies, which are also the most likely to radiate.

Looking at the bead as providing a 100-ohm impedance to the net current, the current that passes out through the bead to the motor and to the chassis which then bypasses the bead sees 100 ohms; while the current that returns through the shield and back through the bead cancels the field from the outgoing current, and thus returns with no "impedance toll" needing to be paid.

Simply grounding the shield at both sides without the presence of the ferrite bead would provide a path for some of the current coupled from the coils to the stator to return back to the driver. This is a preferred return, as the area of the resulting loop (driver ground, to driver, to wire to motor coil, to stator, to shield, to driver ground) is very small as the shield surrounds the driven wires. However, the current divides according to the impedance of both paths, and the chassis commonly has a lower impedance.

Another way of looking at this is the reverse drop across the bead produces a voltage at the output side of the shield such that the shield is "pulling" the current injected by the switching phase charging the winding capacitance back through the shield (as well as the rest of the driver lines) back to the driver chassis. The impedance "toll bridge" of the ferrite bead only applies to one-way currents—not to balanced currents.

As to circulating currents from the ground loop, these see the bead impedance and thus are significantly attenuated so that the bead breaks the loop at high frequencies. The optional series capacitor will break the loop at DC and low frequencies, if that is an issue in your system.

So—balun or shield with bead?

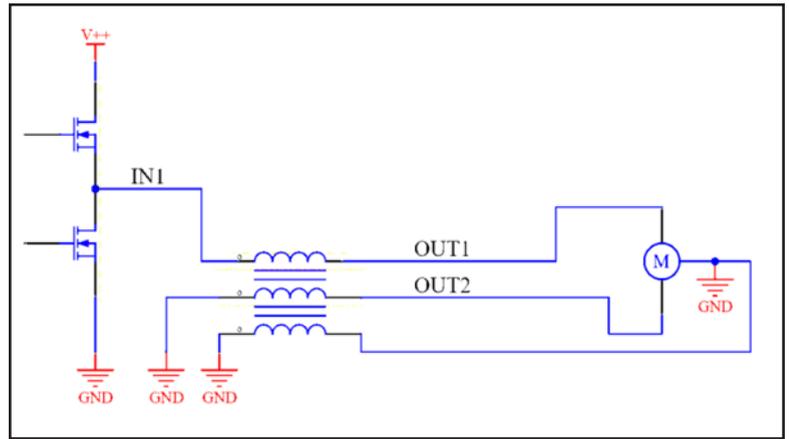


Figure 4 Simplified schematic of a bridge driver showing only the elements about to change state feeding shielded wiring through a balun.

My experience is that if you must choose one, the shield and the bead does more than the balun alone to reduce noise; however, you are free to choose both. A small through board U and I core close to the drivers but capturing all of the driver lines can make a small but effective balun, while still using a shielded cable with a bead to the motor.

**What beads should I use?** I have primarily used type 31 suppression ferrite, as well as type 43 suppression ferrite materials from Fair-rite, but there are many ferrite sources. Lossy ferrites are useful in that they convert the noise into heat rather than just reflecting the energy or resonating it. A small amount of heat is vastly preferable to radio emissions or coupling-switching noise into other nearby circuits.

QuickSilver Controls uses multiple techniques to reduce noise, allowing use of our products in RF-sensitive environments as well as in high-RF environments such as RF susceptibility test chambers. These techniques also allow QCI to use single cables for both motor signals and encoder signals, tested to 200 feet (61 meters)—although we normally suggest shorter runs. **For more information.** Questions or comments regarding this article? Contact Don Labriola at [don\\_labriola@quicksilvercontrols.com](mailto:don_labriola@quicksilvercontrols.com). **PTE**

**Donald Labriola P.E.** is president at QuickSilver Controls, Inc. He has been working with step motors since high school, and has had these motors operating field-oriented closed loop control since 1984.

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# The 2020 Packaging and Processing Experience

## Virtual Pack Expo offers reimagined digital platform

Matthew Jaster, Senior Editor

**Pack Expo Connects takes place November 9-13, 2020 offering virtual chats, educational content, live machine demonstrations and more.** Daily Jumpstart sessions will examine topics such as sustainability, workforce development, and robotics. Trend chats will cover everything from food processing and pharma to digital printing and cannabis packaging. The Solution Room will offer a variety of helpful programs on asset reliability, the supply chain, and the social media vale of LinkedIn. The Innovation Stage will dig deeper into automation requirements, seal integrity, AI, the Digital Twin and manufacturing pivots in a post-COVID environment.

Though the exhibition floor is virtual, it still contains a diverse range of packaging technologies and solutions that will help attendees gain a competitive edge. The following is a preview of some of the products and technologies that will be featured during Pack Expo Connects 2020:

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## Beckhoff

### OFFERS MECHATRONICS AND AUTOMATION TECHNOLOGIES

Beckhoff Automation will showcase innovative mechatronics and PC-based automation technologies during Pack Expo Connects. Flying motion with XPlanar, a stainless steel version of the eXtended Transport System (XTS) and other hardware, software and networking innovations will be on display in virtual booth #213. Beckhoff USA Product Managers will host multiple educational sessions to discuss core packaging technology topics during the weeklong digital event from November 9-13, 2020.

The eXtended Planar Motor system, XPlanar, will demonstrate flying motion during its debut trade show appearance in North America. The system uses planar motor tiles as a base to levitate passive movers at speeds of 4 m/s and acceleration up to 20 m/s<sup>2</sup>. Path planning and collision avoidance software produce extremely efficient and maintenance-free motion control for complex packaging, inspection and material handling applications.



Anti-sloshing functionality based in TwinCAT 3 software optimizes XPlanar's transport capabilities in applications involving liquids, such as filling of beverages, cosmetics and other goods. Wear-free movement and the ability to cover planar motor tiles with stainless steel, glass or another surface ensure XPlanar is a sanitary, wash-down-capable solution. With these capabilities, the innovative system enables ultimate flexibility and allows machines to achieve lot size 1 production.

XTS, the paradigm-shifting linear transport technology from Beckhoff, returns to Pack Expo with new hardware and software expansions. XTS Hygienic, a stainless steel, IP69K version, is ideal for wash-down production environments in packaging, pharma, food and beverage. In addition, new Track Management functionality allows individual movers to transfer between multiple XTS systems, enabling further customization, quality inspection, automatic defect ejection and more. These features, along with the system's high speeds, dynamics, small footprint, instant recipe changeovers and real-time integration with robotics, further revolutionize possibilities in packaging.

Beckhoff drive technology updates at Pack Expo Connects will include new AL80xx Linear Servomotors, additional capabilities from the space-saving, high-performance AX8000 servo system and the U.S. launch of the AA2518 Tubular Motor. With high dynamics and precision, the AA2518 replaces mechanical components, such as spindles, while delivering a maximum force of 1,050 N and acceleration rates of 8 m/s.

Among the other PC-based automation, motion control, IoT and EtherCAT solutions suited to packaging will be TwinCAT Vision and TwinSAFE functional safety. TwinCAT Vision offers comprehensive, real-time image processing to reduce latency and engineering effort using standard PLC languages and GigE cameras. Using the proven EtherCAT industrial Ethernet system, Beckhoff offers a scalable, modular and fully integrated safety system in TwinSAFE, which expands design flexibility, diagnostics and data insights for packaging machines.

“Beckhoff views Pack Expo Connects as an important opportunity for packaging machine builders and CPG manufacturers to connect virtually and continue learning about key technology advances during this unprecedented time,” said Mark Ruberg, packaging industry manager for Beckhoff Automation LLC. “With the market facing new challenges constantly, innovative technologies like XPlanar and XTS Hygienic provide opportunities to future-proof packaging machine designs and enable lot size 1 production. These build on the proven foundation of PC-based automation from Beckhoff, TwinCAT software and EtherCAT, and together they empower new IoT and Industrie 4.0 concepts for packaging.”

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

## Omron

### SHOWCASES COMPLETE AUTOMATION SOLUTION FOR ROBOTICS PACKAGING LINE

Omron will be showcasing several exciting new technologies and solutions at Pack Expo Connects, including a pick-and-place demo that incorporates AI-enhanced vision. The recent addition of AI capabilities to the FH vision system is designed to help packaging companies sort out real defects from noise and varying product patterns.

Collaborative robots will also be front and center with a bin picking demo that features the TM Series cobot and FH Series 3D imaging technology that supports flexible production by quickly and precisely locating parts in a bin.



Another key solution for flexible manufacturing is the AnyFeeder flexible feeding system, which will be combined with an integrated controller PLC programmed using Sysmac Studio and running on an EtherCAT as part of a robotic cell demo.

AnyFeeder is designed for flexibility and rapid changeovers. With automatic vision, conveyor and robot calibration, the demo will show attendees how to achieve faster setup and reduced complexity. With integrated vision enhancing its capabilities, you can eliminate mechanical barriers and increase speed and accuracy.

The collaborative robot, when equipped with the new 3D vision camera, is able to pick up known objects with random overlapping positions out of a bin. Traditionally, this

was difficult to automate due to varying weights, shapes and orientations of objects that require 3D location and different forces during picking. The 3D camera locates objects and sends their coordinates to the robot, while the software makes the advanced calculations required for optimized trajectory and force to pick up objects. The mobile LD robot then transports the sorted goods.

Omron offers a complete automation solution for the robotics packaging line. A multi-robot pick-and-place demo will present multiple integrated technologies designed to enable customization, including three high-speed delta robots working on four conveyors. Robotics and other technologies including vision, motion and control show how intelligent, modular design can create reusable functions and subsystems that improve application flexibility.

([automation.omron.com](http://automation.omron.com))

## Festo

### OFFERS ELECTRIC DRIVES FOR SIMPLE MOTION



The Festo Simplified Motion Series electric drives combines the simplicity of pneumatics with the benefits of electric automation. These new electric drives equipped with Digital I/O and IO-Link enable a range of operational and productivity benefits and deliver intelligent IIoT communication.

The actuators in this series are built for simple motion between two mechanical end positions. The drives offer optimized motion characteristics, including gentle cushioning, while advancing and retracting into the end positions and pressing and clamping functionality. Units in the initial release include toothed belt axis, spindle and toothed belt axis, mini slide, electric cylinder, and rotary drive.

The drives are plug and play for fast startup. No additional software or specific know-how is required. The parameters for advancing and retracting speed, as well as pressing and clamping force, are set directly on the drive. End position, cushioning path, and manual operation are also set on the drive.

Each drive in this series is controlled via Digital I/O. End position feedback, which is similar to feedback from a standard proximity sensor, provides information about the completion of the motion task. IO-Link enables remote control, parameter copy, backup function, and read functions for process parameters.

For those machines and lab instrumentation where compressed air for pneumatics is simply not feasible, the Simplified Motion Series provides a cost effective, easy to apply, and well-featured electric solution. ([www.festo.us](http://www.festo.us))

## NORD

OFFERS A VARIETY OF PRODUCT DEMOS DURING PACK EXPO CONNECTS

### Condition Monitoring for Predictive Maintenance

For condition monitoring, drive and status data are recorded periodically or continuously to optimize the operational safety and efficiency of machines and plants. Condition monitoring provides valuable information for predictive maintenance with the goal to service equipment proactively including avoidance of unplanned downtimes, early detection and avoidance of undesired operating conditions, time-based maintenance replaced by status-based maintenance and more. On November 9 from 12:15 - 12:30 pm Central Time, NORD experts will walk attendees through the core concepts of condition monitoring and the cost-saving benefits of this technology. Q&A to follow.

### LogiDrive with IE5+ Motor Technology

The NORD LogiDrive solution is a complete decentralized drive package that greatly reduces engineering and commissioning efforts. With this modular system, the number of variants can be minimized, making it easier to maintain and saving Total Cost of Ownership (TCO) costs for the operator. LogiDrive systems include: a high efficiency NORD gearbox, IE4 or IE5+ permanent magnet synchronous motor (PMSM), Decentralized variable frequency drive (VFD), Power plug connector, M12 signal connectors, Incremental encoder, Pre-assembled cable, high overload capacity, standardized hollow bore or solid shaft diameters, efficiency at partial load and low speeds. On November 10 from 2:45 - 3:00 pm Central Time, NORD experts will provide an overview of this solution with Q&A to follow.



### Nsd tupH Stainless Steel Alternative

Need the protection of stainless steel, but want a more cost-effective solution for your washdown or other extreme environment applications? NORD's patented nsd tupH sealed surface conversion system gives you the protection of stainless at a fraction of the price. This process conforms to FDA Title 21 CFR 175.300 and is ideal for the food and beverage, dairy, pharmaceutical, and chemical industries. NORD puts a solid, one-piece aluminum case through a chemical process that converts the surface and becomes 6-7 times

harder than the original aluminum alloy. This converted outer layer is extremely durable and will not propagate damage or scratches. Paired with the company's stainless steel hardware and shafting, a unit treated with nsd tupH is comparable to the durability of an all stainless steel unit, but is considerably lighter in weight and is able to dissipate more heat during operation. On November 11 from 2:30 - 2:45 pm Central Time, NORD experts will walk attendees through the benefits of the nsd tupH surface conversion system with a Q&A to follow. ([www.nord.com](http://www.nord.com))

## Regal Beloit

ANNOUNCES MODSORT TRIDENT THREE-WAY SORTATION SYSTEM

Regal Beloit Corporation has announced the introduction of its Modsort Trident three-way sortation system. The company will showcase this newest edition of its modular transfer and divert station at the Pack Expo Connects virtual conference beginning on Monday, Nov. 9.

Part of the Modsort suite of products, the Modsort Trident has a four-zone infeed that gaps a product, reads the package, and sends it down a belt, where it then diverts left, right or straight on a 30-degree spur-curve to one of three sorting locations.



The Modsort Trident is a Regal concept and a continuation of its Modsort technologies, which is known for its quiet operation. Modsort technologies include the Modsort Station (individual transfer), Modsort Derivatives (with expanded sort capacity) and Flat Sorter Systems (with a complete mobile and expandable solution). The Modsort Trident three-way sortation system includes additional mechanical variations to this turnkey solution.

"The Modsort Trident is ideal as a secondary sortation station in a fulfillment center and works well with parcel post, e-commerce and warehouse distribution applications," said Jeremy Fryman, SystemPlast product manager, Regal. "This sortation system can accommodate up to 50 cartons per minute on average, with a weight limit of 50 pounds. It utilizes a 34-inch wide (between frame) x 66 inch long triple-belt divert for polybags, boxes, flats and some types of totes. Modsort Trident technology uses 24-volt DC power and requires only a simple power drop and Ethernet connection to

customer warehouse management solution. Designed to be mobile (the unit comes on heavy duty casters) and can be redeployed if needed to another location.” ([regalbeloit.com](http://regalbeloit.com))

## Bosch Rexroth

### FEATURES NEW CTRLX AUTOMATION PLATFORM

Bosch Rexroth will showcase a new world of automation with its ctrlX AUTOMATION platform, making automation as easy as using a smartphone. Packaging machine builders and end users can virtually eliminate the boundaries between machine controls, the IT world and the Internet of Things with the flexibility to add new automation functions and updates via app to create complete Industry 4.0 automation solutions. The heart of the ctrlX AUTOMATION platform is the ctrlX CORE, the most consistent, open and flexible control platform in the industry. With a Linux real-time operating system, open standards, app programming technology and web-based engineering, ctrlX AUTOMATION reduces components and engineering costs by 30 to 50 percent.



The new platform is ready for standardized and manufacturer-neutral interfaces. In addition to EtherCAT, the system also supports PROFINET and IO-Link. The ctrlX CORE supports more than 30 interfaces to IT systems such as OPC UA and MQTT, ensuring seamless communication and connectivity – from field level up to the cloud. With ctrlX WORKS, the Bosch Rexroth software toolbox, users can also easily assign ctrlX AUTOMATION apps or their own apps to the control.

Join Bosch Rexroth at the PACK EXPO Connects 2020 virtual event to learn how you can automate your Factory of the Future with scalable, connected solutions from Bosch Rexroth. Company experts will give live presentations and technology demos to show you how to implement a fully connected shop floor using ctrlX AUTOMATION. ([pe.show/364](http://pe.show/364))

## Emerson

### HIGHLIGHTS FLOW SENSOR AND INDUSTRIAL PC

The Emerson AVENTICS Series AF2 flow sensor monitors air consumption in pneumatic systems, enabling actionable insight around air consumption and leakage. The leakage rate can be monitored by looking at the used air volume, so leaks can be diagnosed early and addressed before they become a major issue. By giving customers actionable insight on machine data such as flow, pressure and temperature, the AF2 helps to optimize energy consumption, prevent machine downtime and reduce costs. The AF2 is a highly flexible flow sensor that can be directly interpreted by many controllers, and offers multiple communications options, including an IO-Link connection, Ethernet connectivity, OPC-UA server, MQTT communication and on-board webserver. The sensor can be fitted on new installations and its seamless IoT integration makes it perfect for retrofitting existing machines.



The RXi2-LP industrial PC (IPC) edge computer delivers compact, rugged, low power and cost-effective performance computing capabilities to run HMI, historian and analytics applications right at the machine. This enables improved real-time control of operations and better integration into plant-wide systems. Combining strong computing and graphical capability with a low-profile small form factor, the RXi2-LP IPC is ideal for a wide range of industrial applications. ([www.emerson.com/en-us/catalog/aventics-af2](http://www.emerson.com/en-us/catalog/aventics-af2), [www.emerson.com/en-us/catalog/emerson-r2l0n1b1c](http://www.emerson.com/en-us/catalog/emerson-r2l0n1b1c)) **PTE**

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## A Tribute to Daniel B. Jones

It was with sadness we learned of the death of Daniel B. Jones, President of Incomotion Associates. Dan died on September 1, 2020, at his Thousand Oaks, CA home, surrounded by family. Many of the condolences received by the family describe Dan as an industry icon. Dan has participated in the electric motor industry for over 60 years. His involvement started with his mother who was a production manager for an electric motor company in the 1950's, making Dan a second generation electric motor man.



Dan was recognized as an international authority on electric motors and motion control. He was hired by the Korean government to teach engineers motor design. He was known, taught and had clients in China, Japan, Korea, Taiwan, Hong Kong, working with engineers from India, the Middle East and all over Europe as well as North and South America. He authored over 200 technical articles and papers covering technical designs, market trends, etc. in electric motors and motion control.

He was a valuable contributor to industry trade shows and gatherings. He was often asked to chair technical sessions in trade shows around the world. He rarely declined. The list of his membership in professional organizations, where he was often a board member, is impressive:

Until recently a member ASME, Member IEEE, Member AIME

- Advisory Board PCIM Exhibition and Conference Member 1985 - current
- PCIM European Exhibition and Conference Member 1989 - current
- AIME President 1998-1999
- MCA Board of Director's Member 2007 - current
- Member of Board of Directors for AIME 1994 - current
- Advisory Board Member for SMIC (Japan) Conference 1992-2002
- Member of Board of Directors of SMMA (Small Motors and Motion Association) 1999 - 2007
- Member of NEMA Technical Standards Review Committee for Servos and Step Motors 1997 - current
- Member of UK Drives and Controls Conference Advisory Board 1999 - 2002
- Member of UL 1004 Standards Technical Panel 2004 - Current

He was a rarity in the industry who knew the technology well enough to design motors as well as understanding how motors worked in a broad range of applications and markets. He held positions of chief engineer as well as VP of Marketing for motor companies. Early in his career Dan designed a motor that went to Mars in a NASA exploratory mission. As a consultant he stood in as chief engineer when companies

needed help, quickly. As a consultant and employee his mark is on over 100 important motor designs.

He was an avid softball player in to his early 70's. He was deservedly proud of his abilities to help his seniors team win on the field. He traveled all over the United States to play competitively. He was part of history and bible study groups participating with his many friends and church congregants.

His contributions to the industry are legendary. But Dan's most extraordinary contribution was

his openness and generosity to everyone who asked for his help. He willingly and enthusiastically became a teacher and mentor to up-and-coming engineers. He helped and advised seasoned engineers looking to start up their own consultancies, even as they would become competitors to his own consulting business.

The Japanese said Dan had a 'wide face'; an indication of someone well known and well respected in an industry. He was devoted to his family and his faith. He never had a harsh word for anyone. He was a fine man and truly an industry icon. He will be sorely missed.

Dan died of natural causes. He was 84 and is survived by his wife Janice of 60 years and his children Matt, Tom and Sue, 12 grand-children, 7 great grand-children and will join his daughter Jennifer in heaven.

Submitted by George Gulalo, MTT

40+ Enjoyable/Productive Years Collaborating with Dan  
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## Maxon and ANYbotics

### COLLABORATE ON ROBOTIC DRIVE SYSTEMS

Drive specialist Maxon, renowned for its Mars motors, is joining forces with the robotics startup ANYbotics and will in future supply the drive systems of the autonomous ANYmal inspection robot. The robot will soon be marketed in large quantities. This cooperation will also benefit Maxon, since ANYbotics provides important robotics know-how and is



currently the most successful young company in this field.

A solid partnership: Maxon and ANYbotics are entering into a close, long-term collaboration and are thus strengthening Switzerland as a prime location for robotics. One of the decisions made by the two partners is that Maxon, as global

drive specialist, will handle the future development and production of the actuators for ANYmal. ANYmal is an autonomous, four-legged robot that is capable of inspecting and monitoring industrial systems and is destined to also take on dangerous maintenance tasks in the future. The robot can even cope with difficult infrastructures such as stairs and inclines, and is used in a wide variety of industries.

The Maxon Group contributes 60 years of experience in drive technology to the partnership, as well as a global production infrastructure and validated processes, and will help to advance the industrialization and commercialization of ANYmal – with competitive, high-performance drive systems, twelve of which are used in each robot. “In Maxon, we have found the ideal partner for taking care of our drive technology as we transition from small series to mass production. With Maxon’s expertise and infrastructure, we will be able to further optimize a core element of our robots and access state-of-the-art production methods,” says Péter Fankhauser, CEO of ANYbotics.

ANYbotics recently won the Swiss Economic Award 2020 and has been chosen as the best young entrepreneur in Switzerland in the Hightech/Biotech category. The company has valuable experience in robotics – a market that offers great potential for Maxon. Eugen Elmiger, CEO Maxon Group, says: “By collaborating with ANYbotics, we are merging know-how from different worlds. The creativity and high responsiveness of a startup are paired with the global and stable industrial environment of the Maxon Group. Together we will create an energy-efficient and intelligent robotic drive, the likes of which has never been seen before.”

To further cement the partnership, the two companies are also getting closer geographically: Maxon, which has its headquarters in the canton of Obwalden, is opening a lab at the Zürich Campus in the Oerlikon district of Zurich, in close proximity to ANYbotics. Here the engineers and technicians will meet to discuss the progress on their projects. Additionally, Maxon wants to use the lab to get even closer to ETH Zurich and the University of Zurich, offer technical support to young engineers, provide workspaces, and get talent on board.

Elmiger adds: “We are already heavily involved with vocational education in and around Zurich and Lucerne. With the new lab, we will be in an even better position to support talents in drive technology and robotics.” ([www.maxongroup.com](http://www.maxongroup.com))

## SKF and University of Twente

### OPEN STATE-OF-THE-ART TECHNOLOGY CENTER

SKF and the University of Twente which have collaborated for over 30 years have launched a dedicated SKF University Technology Center (UTC) for grease lubrication in rolling bearings.

“Around 80% of industrial bearings are grease-lubricated,” says Professor Piet Lugt, SKF’s senior scientist. “There are clear benefits to be gained from a greater understanding of



the characteristics and behavior of lubricant greases and their application.”

SKF has a number of collaborations with leading technical universities around the world. Professor Lugt has been a part-time professor at the University of Twente since 2011.

His teaching and research focus on bearing failure mechanisms and life prediction, two key areas which are central to helping bearing users to get a better performance from their machinery. He has won a number of academic and industry awards and is author of the definitive book *Grease Lubrication in Rolling Bearings* (2013, Wiley & Sons).

Twente’s Professor Dik Schipper, who will act as UTC director, comments: “Research at the University of Twente in recent years has increased our understanding of the role of grease in bearings. With this knowledge we can reduce energy losses and increase the lifetime of grease lubricated contacts that contributes to a more sustainable society.”

SKF’s Professor Lugt concludes: “Bearings often operate in tough environments and combined with varying speeds and loads, extra demands are placed on the grease. By understanding how the environment affects the grease in our customer’s machines, we can make them run longer.” ([www.skf.com](http://www.skf.com))

## ABB

### NAMES NEW PRESIDENT OF US MOTORS AND GENERATORS DIVISION

ABB’s Motors and Generators division has named Jesse Henson president of their US business.

Henson, who has been with the company for 23 years, leads the team responsible for marketing, designing, and manufacturing ABB and Baldor-Reliance industrial electric motors in the United States. Henson will also continue to be

the global head of the NEMA motors product group.

“I am honored to lead the US industrial motor business,” said Henson. “Taking care of customers is in our employees’ DNA, and we work hard every day to earn our customers’ business and their preference for our motors. I am committed to maintaining that focus and investing for the future.”

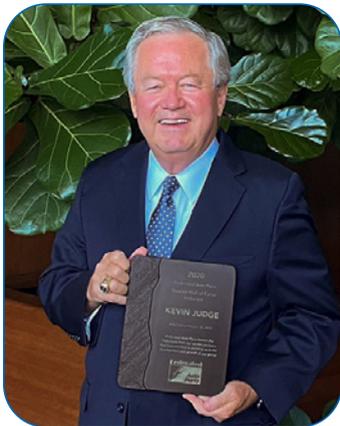


Henson started his career with the company (Baldor Electric Company at that time) in 1997 as part of the drives and motion control team. His customer-first approach has been critical to his success in roles in product management, marketing, and sales. His broad experience across both motors and drives provides a strong level of understanding of customer and application needs as well as buying preferences in the US market. ([www.abb.com](http://www.abb.com))

## NTN's Kevin Judge

INDUCTED INTO FEDERATED AUTO PARTS VENDOR HALL OF FAME

NTN is proud to announce that **Kevin Judge**, vice president, sales and marketing — automotive aftermarket, has been announced as the 2019 inductee to the Federated Auto Parts Vendor Hall of Fame. This honor was announced during the The Group's recent Annual National Conference and Expo, which took place virtually and featured a virtual happy hour to celebrate Judge and other award winners.



The Hall of Fame award announcement from Federated stated, "Kevin Judge has worked with Federated members almost from the start in a variety of different positions for multiple supplier partners. His counsel and support has been extremely valuable to many members and is a great example of this awards intent. Kevin can always be counted on to provide insight and expertise about a variety of topics and is a valued partner to Federated members."

"We are proud of Kevin for achieving this honor," remarked Pete Eich, president and CEO of NTN Bearing Corporation of America, "This is not a company award for NTN, it is instead recognition of Kevin as a longstanding, respected fixture in the automotive aftermarket. This award is very well deserved for the contributions Kevin has made to the success of NTN and our valued customers like Federated Auto Parts."

According to Federated, the Vendor Hall of Fame is an honor established by Federated members since 1985 to honor the vendor partner who has contributed to the success of Federated members. The award recognizes an individual who has gone above and beyond to offer advice, guidance, and support to the membership. The award recognizes efforts that may go beyond the scope of a job assignment and focuses more on the relationship with the individual.

Judge has worked in sales, marketing and management roles in the automotive aftermarket for over 40 years. In his tenure with NTN he has been key to the establishment of NTN's automotive aftermarket business unit and the growth of NTN's aftermarket brands; BCA Bearings for automotive and Bower Bearings for Heavy Duty Truck. ([ntnamerica.com](http://ntnamerica.com))

## Poggi

ENHANCES CAPABILITIES WITH PHOTOVOLTAIC SYSTEM

A network connected photovoltaic system, with a unit capacity of 394.52 kWp was recently installed at Poggi Trasmissioni Meccaniche S.p.a. The system, connected to the network and installed on the roof of the company, consists of 1,409 modules of 280 W and, according to the appraisal made by SIAT technicians, will have a production capacity of 459,853 kWh/year.



This will allow Poggi Trasmissioni Meccaniche S.p.a. to reach a significant energy saving and to consequently devote larger resources for research in the field of transmission parts. This activity has always distinguished the company through the design of leading-edge solutions, capable of bringing innovation to the sector. Current examples of this capability are P-drive, a range of low-noise and high-performance synchronous pulleys and belts and the P-gear concept, motion transmission system with non-contact gears, applied in the field of bevel gearboxes and reducers.

"We are very proud of the project," said Andrea Poggi, president of the company. "The investment in photovoltaics reflects a radical commitment to sustainability, a responsibility towards the environment that will continue to characterize our history also in the coming years through choices and strategic decisions aimed at maximizing the use of renewable resources and energy." ([www.poggispa.com/?land=en](http://www.poggispa.com/?land=en))

## Bosch Rexroth

ANNOUNCES MANAGEMENT CHANGES

**Paul Cooke**, president and CEO of Bosch Rexroth North America, based in Charlotte, NC, USA, will retire on December 31, 2020 after 38 years of distinguished service in various international positions within Bosch Rexroth.



His successor as of December 1, 2020 will be **Greg Gumbs**, most recently vice president and general manager electrical automation solutions at Eaton Corporation. Gumbs will join Bosch Rexroth effective September 1, 2020 in preparation for his future responsibility and will be based at Bosch Rexroth

North American headquarters in Charlotte, NC.

After completing his degree in electrical engineering, Gumbs started his professional career in 1997 as an application engineer in the Global Technical Service Group of Rockwell Automation, Inc. He later held various drive systems engineering, sales, marketing, services and management positions within Rockwell before taking over as director commercial sales support and market development.

In 2007, Gumbs joined the Eaton Corporation Industrial Sector as vice president sales Americas for hydraulics business. In 2013, he became general manager for the hydraulic hose and fittings business. In 2015, he moved to Eaton electrical sector as vice president and general manager of Eaton Electrical Automation Solutions.

“Bosch Rexroth is an amazing organization with a bright future given the strong foundation of technology leadership and customer focus. I am honored to join the Bosch family and looking forward to leading this talented team forward in close partnership with our channel partners,” said Gumbs.

In addition to an electrical engineering degree from DeVry University, Gumbs obtained his MBA with a focus on Leadership and Global Business Management from Weatherhead School of Management at Case Western Reserve University. ([www.boschrexroth-us.com](http://www.boschrexroth-us.com))

## Motion Industries

ACQUIRES MOTION CONTROL/AUTOMATION COMPANY

Motion Industries, Inc. has completed the acquisition of Applied Machine and Motion Control, Inc. (AMMC), a Kentucky-based supplier of motion control and automation products and services. The transaction closed with an effective date of September 1, 2020.

Founded in 1995, AMMC is headquartered in Park Hills, Kentucky, outside of Cincinnati. The majority of AMMC’s business comprises the markets of Indiana, Kentucky, Michigan, Ohio, Western Pennsylvania, and West Virginia.



The company’s engineering and application expertise propels its specialty services including motion control, drives, HMI, PC and embedded control, automation control, mechanical, robotics, motors, and mechatronics. AMMC’s customer base consists primarily of OEMs, plus a number of end users. “We are very excited to join the Motion team,” said David Locke, AMMC president and founding partner/owner. “The cultural fit and our common goals make it an ideal match, and we look forward to contributing to the Company’s growth. Through Motion, we will have access to even more products and capabilities to enhance our value proposition and level of service to our customers.”

“As a premier supplier to the Ohio River Valley area and beyond, AMMC and its talented people will be instrumental in furthering our growth strategy geographically and in the automation arena,” said Motion Industries President, Randy Breaux. “In addition to broadening our offerings to customers, their go-to-market approach and line card are very similar to our other Mi Automation Solutions Group divisions, to which AMMC will be a nice complement. We are pleased to welcome them to the Motion family.”

Mi Automation Solutions Group offerings to customers include control panels, conveyors, machine vision, motion control, network connectivity, pneumatics, robotics, aluminum extrusion, sensing I/O, and other automation-related solutions. ([Motionindustries.com](http://Motionindustries.com))

## EUROTRANS

ANNOUNCES NEW LEADERSHIP

The European power transmission engineering industry met for its annual meeting of the European Power Transmission Sector Committee EUROTRANS on September 29, 2020.

This year’s meeting focus was on the challenges of COVID-19. “COVID-19 functions as a catalyst for digitalization, it will speed up processes in our societies, in our global industry, and in the power transmission industry,” said Eric Goos, general manager of Hansen Industrial Transmissions N.V., Belgium plant of Sumitomo Drive Technologies. He is the outgoing president of EUROTRANS and established a modern organization which is well prepared for the challenges of the future. During the annual meeting, **Salim Haffar**, I-MAK Gearboxes and Drives, Turkey was elected as president and **André Thuswaldner**, Novagear AG, Switzerland was elected vice president.

“Digitalization and sustainability will be one of the key challenges for our industry – to be successful in the future



we need cooperation and networking opportunities beyond national borders and technologies,” said Haffar. During the discussions with managers from all over Europe, there was general agreement that the European power transmission industry with its cutting-edge technologies and global presence is a leading player in the global market, and a strong European network such as EUROTRANS is fundamental to strengthen this position. The European power transmission industry expects a minus of 20% in 2020 and a growth between 5 to 10% in 2021

Although the economic situation is a big challenge for the power transmission industry, some customer groups are quite positive, such as the semiconductor industry, pharmaceutical industry, railway industry and logistics industry.

“Our industry in Europe is innovative and on a long-term perspective it will grow further. EUROTRANS is an ideal forum to discuss future trends within an international management,” said Thuswaldner. ([www.euro-trans.org](http://www.euro-trans.org))

## Sentient Science and Croda

### PARTNER FOR WIND ASSET LIFE EXTENSION

Croda International Plc, which uses smart science to create, make and sell specialty chemicals that improve lives, has recently announced a new partnership with Sentient Science (Sentient) for the recommended use of Croda’s Rewitec additives for wind turbine gearboxes and main bearings.

In 2019, Croda acquired Rewitec GmbH and began to offer Energy Technologies customers nano- and micro-particle-based additives to increase the durability of machinery by lowering friction and reducing wear. Sentient Science validated Rewitec’s DuraGear gearbox oil additives for use in wind turbine gearboxes in 2017.

This brand-new partnership will see Sentient apply physics and data science expertise, combined with Croda’s Rewitec additives, to calculate the lifetime extension of critical rotating components. It will also examine how Rewitec’s GR400 grease additive, developed specifically for main bearing durability improvements, can improve equipment lifetime.

Sentient Science provides DigitalClone for Wind Operations and Maintenance, which uses a unique combination of physics and data science to give a holistic view of the health and remaining useful life of an asset’s critical systems and components. This information is used for predictive maintenance programs to reduce operations and maintenance costs and ultimately to prolong asset life. Sentient is able to calculate and demonstrate durability improvements imparted through using Croda’s Rewitec technology, which provides asset owners the option of extending the lifetime of their assets instead of costly part replacements.

“The competitive energy market is forcing energy producers to optimize maintenance practices and reduce operational expenses,” said Scott Gardiner, Business Development Specialist, Energy Technologies at Croda. “Major correctives are the largest cost drivers in the wind energy market, specifically gearbox or main shaft replacement. The cost of this



replacement can completely change the asset’s profitability during its lifetime. The Rewitec technology is currently helping customers reduce failure rates and extend the life of these critical assets. We are excited that customers can now utilize Sentient’s DigitalClone to provide RUL projections in conjunction with our Rewitec technology.”

“As wind turbines age, operators are seeing a higher number of onshore and offshore wind assets running with damage, specifically in critical rotating components like gearboxes and main bearings,” said Ed Wagner, GM of wind operations at Sentient. “Our customers have been waiting for data to compare next generation additives, like Rewitec, against uptower part replacements. And while this may not be a solution for every wind turbine, we do have data to substantiate improvements in gearbox life and expect to show the same in main bearing life.”

([www.croda.com/en-gb](http://www.croda.com/en-gb))

## Missouri S&T Alumnus

### CONTRIBUTES 10 MILLION TO UNIVERSITY

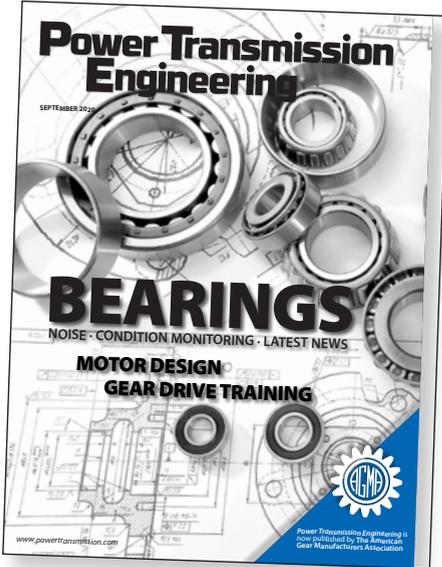
Missouri University of Science and Technology alumnus Bipin Doshi and his wife, Linda, have made the largest individual contribution to an academic program in university history: a \$10 million gift to the department of chemical and biochemical engineering.

Their gift establishes an endowment, which will name the department and provide funding for an endowed chair to be held by the department chair and two professorships in support of exceptional, mid-career faculty members. The endowment will eventually support additional departmental needs including technology acquisitions and upgrades, fellowships, and seed funding for accelerating research to market.

“We are deeply grateful for Linda and Bipin Doshi’s investment in our university and the department where Bipin laid the foundation for his distinguished career,” says Missouri S&T Chancellor Mo Dehghani, who announced the gift during the university’s 150th anniversary online celebration. Learn more here: <https://www.powertransmission.com/news/10773/Missouri-ST-Alumnus-Contributes-10-Million-to-University/>

# Power Transmission Engineering

## Power Transmission Engineering's Statement of Ownership, Management and Circulation



Additional information about *Power Transmission Engineering* and its audience can be found in our 2021 media kit. Download it at [www.powertransmission.com/adinfo.htm](http://www.powertransmission.com/adinfo.htm)

**UNITED STATES POSTAL SERVICE®** Statement of Ownership, Management, and Circulation (Requester Publications Only)

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13. Publication Title		14. Issue Date for Circulation Data Below	
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<b>a. Total Number of Copies (Net press run)</b>			
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(1)	Outside County Paid/Requested Mail Subscriptions stated on PS Form 3541. (Include direct written request from recipient, telemarketing, and Internet requests from recipient, paid subscriptions including nominal rate subscriptions, employer requests, advertiser's proof copies, and exchange copies.)	5,952	5,818
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(4)	Requested Copies Distributed by Other Mail Classes Through the USPS (e.g., First-Class Mail®)	-	-
<b>c. Total Paid and/or Requested Circulation (Sum of 15b (1), (2), (3), and (4))</b>		6,219	6,106
<b>d. Non-requested Distribution (By mail and outside the mail)</b>			
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<b>e. Total Nonrequested Distribution (Sum of 15d (1), (2), (3) and (4))</b>		7,998	8,055
<b>f. Total Distribution (Sum of 15c and e)</b>		14,217	14,161
<b>g. Copies not Distributed (See Instructions to Publishers #4, (page #3))</b>		300	300
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16. Electronic Copy Circulation

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a. Requested and Paid Electronic Copies	3,314	3,295
b. Total Requested and Paid Print Copies (Line 15c) + Requested/Paid Electronic Copies (Line 16a)	9,533	9,401
c. Total Requested Copy Distribution (Line 15f) + Requested/Paid Electronic Copies (Line 16a)	17,531	17,456
d. Percent Paid and/or Requested Circulation (Both Print & Electronic Copies) (16b divided by 16c * 100)	55%	54%

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17. Publication of Statement of Ownership for a Requester Publication is required and will be printed in the October 2020 issue of this publication.

18. Signature and Title of Editor, Publisher, Business Manager, or Owner  
 Randy Stott, Publisher & Editor-in-Chief  
 Date: 10/1/2020

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

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# Mechanical Wonders of All Sizes

Jack McGuinn, Senior Editor

**The industrial arts of mechanical engineering are all around us and seen in many forms and technologies.** Of greatest interest is how these wonders are designed, constructed and used. From the smallest home appliance to the behemoths used for outside building and excavation projects, for example, mechanical engineering drives the conception and completion of such wonders. And while, as mentioned, these machines are everywhere, a surprising number of them go unnoticed and unheralded. Following are just a few examples of the power, motion control and ingenuity needed to make these machines and devices a reality.

## Aircraft Carrier USS GEORGE H.W. BUSH (CVN-77)

Named for President George H.W. Bush, the (CVN-77) was built by Northrop Grumman Newport News and commissioned in 2009. CVN-77 is the last among the Nimitz Class aircraft carriers that are nuclear powered. The total cost of building the ship was \$6.2 billion. This giant carries two nuclear reactors that can power the ship for more than 20 years without refueling. The CVN's maximum speed is recorded at more than 30 knots. She has a unique bow design that reduces the drag by providing better hull efficiency and bet-



Aircraft Carrier USS GEORGE H.W. BUSH (CVN-77) (Source: U.S. Navy photo by Mass Communication Specialist 3rd Class Nicholas Hall/Wikimedia Commons.)

ter buoyancy to the forward portion of the carrier. The vessel stretches to about 1,092 feet and has a flight deck 76.8 m wide and 332.9 m long. She carries a total of 6,000 crew members and accommodates more than 60 aircraft. Including the stores, fuel, ammunition, and water, it has a full load displacement of about 102,000t.

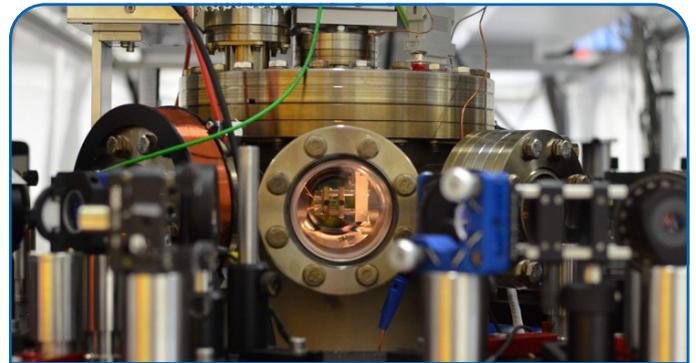
## RoboFly — A Tiny Flying Robot That Can Operate Wirelessly

No, this not a Hollywood special effect. Engineers from the University of Washington have designed a robotic fly that is half the size of a paper clip and weighs in at only one-tenth of a gram. The wireless flying robot is made possible through a photovoltaic cell, which is attached above the RoboFly and converts the remotely pointed invisible laser beam to elec-

tricity. The fly is also equipped with a microcontroller that acts as a brain to help the RoboFly gain control over its own wings. It essentially directs the wing muscles when to flap hard and when not to. While the current iteration of RoboFly is still limited in terms of capabilities, there are plans to develop an advanced version with integrated batteries, advanced brains and sensor systems which will help the fly to navigate and perform tasks on its own. Most importantly, the completely realized robotic fly will have significant potential in areas of search and rescue missions, surveillance, climate monitoring and more.

## Nano Engine — An Engine that Works on a Single Atom

Scientists at the University of Mainz in Germany were successful in building the smallest working engine ever created. It is powered by a single electrically-charged calcium atom and reputedly has the similar thermodynamic efficiency (when scaled to size) of an average automobile engine. Indeed, the nano engine follows the same thermodynamic cycle that occurs in a normal car engine. However, in this case, the power generated is converted into a vibration of an atom that provides the mechanical motion. The scientists in their experiment were also able to observe a power output of  $10^{-22}$  watts with an efficiency of around 0.3 percent. While there admittedly at this time may not be any direct application of the single-atom engine, with modifications, this micro-engine can lead to more opportunities in studying small quantum machines.

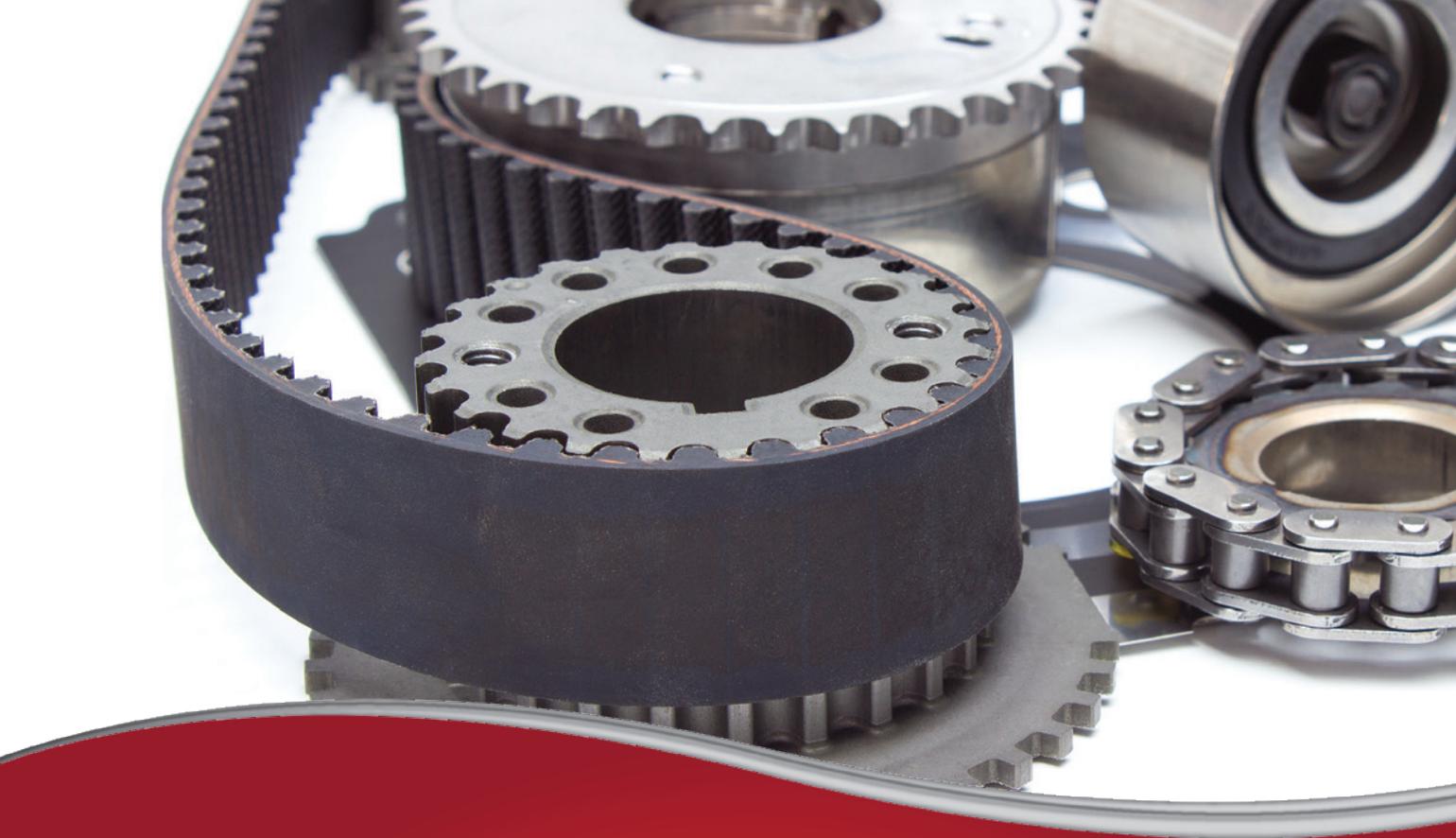


Nano Engine – Engine That Works On A Single Atom (Source: AG QUANTUM/JGU.)

## Belaz 75710 — World's Largest Dump Truck

With a massive weight of 793,664 lbs., the Belaz 75710 is indeed the world's largest dump truck with a hauling capacity of 992,080 lbs. To achieve such a feat, the giant dump truck consists of eight wheels, each capable of supporting 224,872 lbs. The gigantic truck is powered by two 16-cylinder diesel engines that churn out an incredible 3,430 kW of horsepower with a top speed of 64 km/h. Built by a Belarusian company, this big guy comes with a cost of about \$6 million. **PTE**

Source: Kashyap Vyas, *Interesting Engineering*.



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