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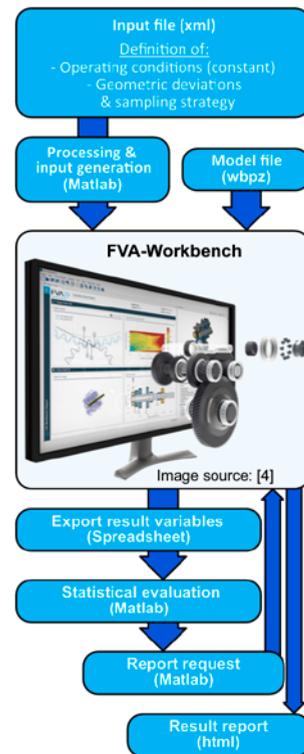
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A Publication of
The American Gear
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Power Transmission Engineering

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PTE Extras Fact or Fiction?

In everyday life and in the technical fields we often discover that certain decisions are based on “scientific data” when, in fact, they are often founded on historic conclusions that have not been challenged or re-evaluated in a long time. One such common myth is that for a stable and well-tuned drive you should match the motor’s inertia to the load inertia, which is typically done using a gearbox.



powertransmission.com/blogs/3-motor-matters-with-george-holling/post/9400-fact-or-fiction

Atlanta Gear Works Offers Step-by-Step Process for Rebuilding a Beloit Differential

In paper mills throughout the country, gearboxes provide an integral solution for power transmission. Each is selected particularly and directly to perform a specific task in the production of paper. Due to the critical nature of the equipment, all gearboxes are heavily monitored and periodically inspected for preventive maintenance. If necessary, gearboxes can be reconditioned by replacing or repairing components with the intent to rebuild the entire gearbox to OEM specifications.



powertransmission.com/blogs/1-revolutions/post/9393-atlanta-gear-works-offers-step-by-step-process

Bosch Rexroth Presents Integrated Product Transport Solution

To be competitive in the current market, manufacturers must package products faster, and at lower cost. To efficiently produce individualized products and small batch sizes, manufacturers must have a high degree of flexibility. In addition, space is often a scarce commodity in production. With the VarioFlow plus chain conveyor system, Bosch Rexroth supplies an essential component for flexible and economical transport within a plant. It conveys packed and unpacked goods vertically and horizontally in the smallest possible space. Together, with the spiral transport system from smartPac Srl, manufacturers benefit from a continuous spiral transport system with low commissioning and maintenance costs.



powertransmission.com/blogs/1-revolutions/post/9348-bosch-rexroth-presents-integrated-product-transport-solution

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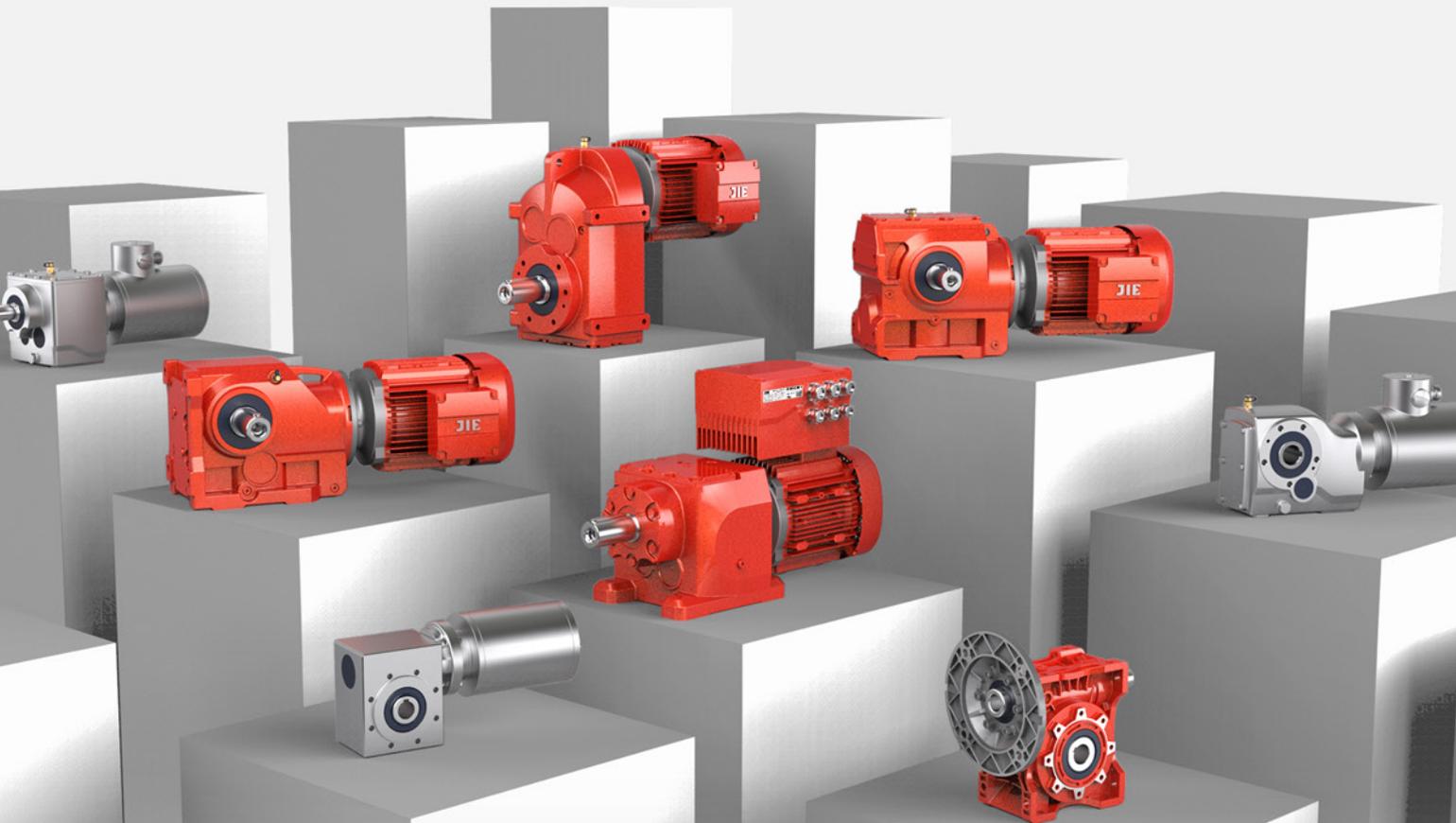




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Show Up

Trade show and event season is upon us. This issue we feature several upcoming shows that are extremely important in terms of mechanical power transmission components and the technology of motion control.

First up is **Pack Expo Las Vegas**, which takes place September 11–13 at the Las Vegas Convention Center. This show, focusing on the packaging and material handling industries, is always full of exhibits featuring the latest technology in gear drives, gearmotors, bearings, automation and much more. The event organizers promise that this will be the largest Pack Expo in history, with nearly a million square feet of exhibit space. You can learn more at packexpolasvegas.com or read Senior Editor Matt Jaster's article on page 30.

I'm also pleased to say that Senior Editor Aaron Fagan will be attending this year's **International Conference on Gears**, organized by VDI and held at the FZG facility in Garching, Germany (vdiconference.com/event/international-conference-on-gears), where more than 120 technical papers will be presented on all aspects of gear design, manufacture and R&D. If you happen to be going to the conference, please make a point of saying hello to Aaron!

Next up is the **Turbomachinery and Pump Symposia** (tps.tamu.edu), which takes place September 26–28 at Houston's George R. Brown Convention Center. TPS is a great annual event for anyone in the oil & gas, wastewater, petrochemical and other industries featuring large rotating equipment and pumping systems. In fact, we'll be exhibiting at the show, in booth #1501, so we hope you'll come see us there. In the meantime, don't miss Senior Editor Aaron Fagan's preview article on page 18.

And, of course, we're working very hard putting the finishing touches on our plans for **AGMA's Fall Technical Meeting** (October 16–18) and **Motion + Power Technology Expo** (October 17–19) at Detroit's Huntington Place (see our article on p. 38). All of our editors will be at MPT Expo, as well as many other members of the AGMA and AGMA Media teams.

At MPT Expo, we're putting on a Live edition of our popular "Ask the Expert" feature in booth #3136. We'll have four one-hour sessions with discussions on:

- The Future of Gear Manufacturing (Tuesday, 10/17 @ 10:30)
- Gear Manufacturing for Electric Vehicles (Tuesday, 10/17 @ 2:30)
- Automation for Job Shops (Wednesday, 10/18 @ 10:30)
- Solving the Skilled Workforce Challenge (Wednesday, 10/18 @ 2:30)

These interactive sessions will each feature a panel of three to four experts, and audience participation is strongly encouraged!

Our team's travel schedule is extremely full over the next couple of months, and we hope yours will be, too. They say that half the battle is just showing up. There are quite a few upcoming opportunities for you to do so. We look forward to seeing you at one of these great events.

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PROVIDES ADVANTAGEOUS CORROSION PROTECTION FOR EXTREME OPERATING CONDITIONS



Harsh operating conditions are present in many industries such as food and beverage, bakery, automotive parts washing, chemical, water treatment, marine, car wash, and pharmaceutical industries. Applications in these environments are often subjected to intensive cleaning, high-pressure washing, and disinfection processes to meet the highly regulated, hygienic standards. To prevent gearmotors from material destruction due to the rigorous cleaning agents and disinfectants, Nord Drivesystems developed nsd tupH—a sealed surface conversion system that ensures easy yet safe cleaning, ultimate surface durability, and wear resistance.

The nsd tupH treatment uses a chromate-free chemical process that permanently alters the aluminum housing's physical properties to create a surface that is up to seven times harder than the original. A clear sealant is then applied on top of the base layer to form a smooth surface that is easy to clean and maintain. The sealant also provides additional protection against acids and alkalis and will not spread corrosion, even if damaged. When compared to traditional surface protection methods such as paint, nsd tupH will not blister, flake, or chip and provides a more durable corrosion resistance.

Stainless steel units are often used in similar harsh environments but unlike nsd tupH units, are heavy, costly, and dissipate heat poorly. The advantages of using aluminum products are the material's inherent low weight, compactness, and ability to effectively

conduct heat, keeping operating temperatures low and prolonging the service life of the internal transmission components. Another advantage of nsd tupH compared to stainless steel is the product availability. Whereas stainless steel can only be used with a small range of products, nsd tupH is available with a wide variety of Nord's modular drive system options such as: Nordbloc.1 helical inline gear units, Nordbloc.1 two-stage helical bevel gear units, Unicase parallel shaft gear units, Universal SI worm gear units, Universal SMI worm gear units, DuoDrive integrated gear units, Smooth surface motors and Nordac On/On+ variable frequency drives.

Nord units that are treated with nsd tupH also include additional hygienic options such as stainless-steel shafts and hardware, special shaft sealing rings to prevent moisture from entering the gear unit, and IP69- rated protection. Additionally, nsd tupH conforms to FDA Title 21 CFR 175.300 and can be built with synthetic or mineral food grade lubrication for applications with extreme temperatures or those in the food and beverage industry.

Moisture, acids, alkalis, and salts are present in many applications in the food and beverage industry, making rapid drive deterioration a constant concern. Painted cast iron units used in these environments often fall short of demand and see a high turnover rate. Nord's nsd tupH drive systems, however, are engineered for robustness and even provide durability in the humid, salty atmospheres of the seafood industry where conventional cast iron units can begin to rust within several weeks and stainless-steel units require long cool off periods before they can be hosed down.

Not only is nsd tupH ideal for hygienic applications, but it is also beneficial in industries such as wastewater treatment where drive systems are exposed to fluctuating temperatures and harsh outdoor conditions. Treating these systems with nsd tupH prevents corrosion from wastewater, precipitation, and chemical cleaning. This durable solution ensures units have a long lifespan with more efficient operation and fewer system replacements.

With the nsd tupH sealed surface conversion system, Nord Drivesystems offers a reliable surface treatment solution for gearboxes, motors, variable frequency drives, and components to withstand extreme system conditions.

nord.com

Bonfiglioli

INTRODUCES KIT FOR BATTERY-POWERED MINI EXCAVATORS



Bonfiglioli has announced the successful testing and validation of its highly advanced kit of products designed for battery-powered mini excavators. Following rigorous evaluations by multiple original equipment manufacturers (OEMs) across all continents, the results demonstrate an extraordinary improvement in energy efficiency, surpassing industry standards by at least 20 percent.

Recognizing the growing demand for sustainable and eco-friendly construction equipment, Bonfiglioli has developed a cutting-edge solution tailored specifically for battery mini excavators. Carefully engineered and meticulously tested, it incorporates the latest advancements in power transmission and control technologies.

The Bonfiglioli kit comprises three key components that significantly enhance energy efficiency in battery mini excavators:

1. Electric Swing Drive (700T Series): The 700T series electric swing drive provides exceptional precision and power to the swing mechanism of the mini excavator. With rotation being the most frequently used movement during the working day, electrifying it enhances energy efficiency, allowing for prolonged operation on a single charge.

2. Electric Track Drive (700C Series):

The 700C series electric track drive (pictured above) optimizes the performance of the track system, keeping a low level of energy consumption and increasing maneuverability. Seamlessly integrated with the machine, it ensures reliable operation even in harsh working conditions.

3. Electric Motor for Pump Drive (BPM Series):

The BPM series electric motor is designed to drive the arm and the bucket, as well as other challenging-to-electrify functions which are usually hydraulically driven. This minimizes the redesign effort, contributing to overall energy savings.

The energy efficiency improvements reached through the kit offer numerous advantages to construction companies and operators, including extended operating time, reduced downtime for recharging, increased productivity, and significant cost savings over the lifespan of the mini excavator.

“The exceptional results achieved by our battery mini excavator kit underscore Bonfiglioli’s commitment to innovation and sustainability,” said Fausto Carboni, CEO of Bonfiglioli Group. “By leveraging our advanced power transmission and control solutions, construction professionals can now access a superior alternative that enhances energy efficiency without compromising performance, furthering our collective efforts towards a greener future.”

bonfiglioli.com

Nexen

ANNOUNCES NEW LINE OF ROTARY INDEXERS

Nexen Group, Inc., announced a new line of Rotary Indexers. The X-Line delivers up to three times more torque and greater moment load capacity in a compact package.

Nexen’s X-Line has a redesigned roller pinion and a larger gear pitch to handle higher torque capacities that deliver accuracy, fast acceleration, high-speed positioning, increased load capacity, and true repeatability.

The X-Line’s mounting features and the additional fastening points of the rigid cast housing are designed for a greater moment load capacity than a standard design. Additionally, systems can be designed for low or zero backlash to meet the project specifications.



“We designed the new X-Line Rotary Indexers from our customer requests to have a system that delivers higher torque and more load capacity,” said Dave Hein, vice president of engineering. “Utilizing Nexen’s patented technologies, we were able to create systems that deliver a solution for the most demanding applications that require precise positioning and higher peak torque inputs, allowing for faster indexing times.”

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Fixtureworks

OFFERS MECHANICAL LINEAR ACTUATORS



Fixtureworks (Fraser, MI) a North American manufacturer and supplier of clamps, fixturing accessories, machine tool components and rollers & bumpers, now offers a line of mechanical linear actuators.

These mechanical linear actuators are preassembled and ready to use. No part selection, no designing and no assembly is necessary on these simple to use manual linear actuators. The carriage moves along with the rotation of the shaft. The internal parts are protected from dust by its aluminum profile body and dustproof sheet. There are different types of linear actuators available such as a standard size or a compact type with a lighter body and for use in smaller spaces. They are available for use as a single unit or as a linked, synchro-use dual unit.

The standard or traditional mechanical linear actuators comes with a single carriage that moves along with the rotation of the shaft. They can be used horizontally or vertically.

With the synchro-use dual actuators, the two carriages move toward each other when the handle shaft is turned clockwise. The two carriages move away from each other when the handle shaft is turned counterclockwise. As with the standard linear actuators, they can be used with simple manual adjustments without complex processes of parts selection, design and assembly. The internal parts, as well, are protected from dust by an aluminum profile body and dustproof sheet.

A variety of accessories are available that are made for use with Fixtureworks mechanical manual linear actuators, such as adaptor shafts that are designed to extend and adapt the diameter of shafts of the compact mechanical linear actuators, shaft locks that can be used to prevent

actuator shafts from rotating. T-Nuts, stops and groove covers are also available. Indicator handwheels and knobs connect to any spindle with a set-screw. Indicators have a wide range of applications such as reading revolutions, reading slide feeds, reading flow rate and reading conveyor speed.

In addition to mechanical linear actuators Fixtureworks offers form holding clamps, quick change pneumatic clamping fasteners, quick action sliding locks spring plunger clamps, handle and levers, knobs and grips, equipment handles, hand wheels and cranks, hinges and latches, leveling supports, industrial rubber bumpers, stops and wheels, fixture clamps, clamping locating systems, work positioning elements, vises, and grippers.

fixtureworks.com

Ogura

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Spring applied brakes that are zero backlash, quiet, super thin profile, low power, light weight, and less expensive than current solutions.

Ogura's new MCNB-Z series Spring Applied Brakes are changing the way robotics and medical equipment designers look at power-off holding brakes. These are used for both safety and precision motion control. For decades, permanent magnet type brakes were the only reliable solution. This is no longer the case, thanks to this new breakthrough design.

The product is spring applied type and truly zero backlash, which is unique. This means that loads can be held precisely when power is removed, improving the quality of the machinery and process. Traditional designs held zero backlash in the axial direction by fixing the hub to the friction

disc, but this design also incorporates zero backlash in the rotational direction by removing play between the armature to the collar. This is important to note.

The applications involved are often noise sensitive, so the innovative design enables quiet actuation at 60dB or less.

The special construction of the internal brake results in the lowest possible inertia of the hub and friction disc, which is very desirable in high cycling and high-speed applications. This is possible because the friction material is not bonded to the rotating disc, the material is bonded to the stationary components.

The product is compact with a super-thin profile and light weight. This provides benefits to robotic arm and motion control designers desiring smaller footprints, quicker system response times, lower system weight and cost.

Spring applied brake technology allows for lower power consumption as overexcitation releases the brake quickly, and pulse width modulation after the brake is released allows for 50 percent or more power savings. Reduced power then results in lower heat, extended overall component and system life. This allows improved warranties, reduced maintenance, and superior performance. They also offer distinct advantages in wide temperature range applications.

Lastly, they are easier to install since they are one piece construction as opposed to two-piece permanent magnet type construction.

Three standard sizes are available from 0.38 to 3.8 Nm static torque. All have length of 27.7 mm or less, 32 mm or less if you add the hub. Custom sizes can be considered.



ogura-clutch.com



UNVEILS THERMAL MANAGEMENT SYSTEM FOR EVS

ZF recently unveiled its self-developed thermal management system for electric vehicles at its annual Global Technology Day demonstration event. The new system not only offers a more compact design of the drive but can also increase the range of vehicles in winter by up to one third. In combination with an optimized electric drivetrain consisting of power electronics, motor and reduction gearbox based on 800-v silicon carbide, the system sets new standards in compactness and weight. The newly developed powertrain software also makes a significant contribution to higher efficiency.

“With this innovative solution, ZF is underlining its system expertise in electromobility and providing e-cars with a greater range,” said Dr. Holger Klein, CEO of ZF. The new powertrain is free of heavy rare earth elements and can be used flexibly by car manufacturers thanks to its modular design. After presenting the concept last November, ZF has now realized the new generation of the electric drive with thermal management in a demonstration vehicle, which the company presented to journalists from all over the world at its headquarters in Friedrichshafen.

In the vehicle, the components of the electric driveline have been optimized and combined into a holistic system. The drive package has a 30 percent lower overall weight and, in this way, together with thermal management, enables a torque density of 70 Newton meters per kilogram of drive weight. This is a peak value for road-legal passenger cars currently available on the market. “Just a few months ago it was only a vision, now our drive can be experienced in a sports car,” said Klein. “Not only are we consistently pursuing our strategy of sustainable and efficient mobility for the future, but we are also adapting our development processes to the new speed of our industry.”

In view of the increasing speed and dynamic environment of change taking place in the automotive industry,



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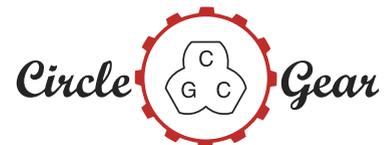
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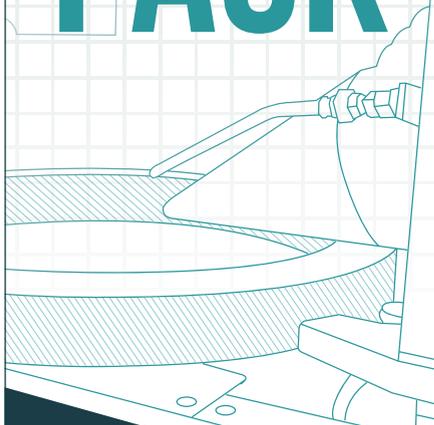


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ZF has also been optimizing its organization for several months: decision-making paths will be shortened, and processes made more agile to help the company be more responsive. ZF's global orientation is already proving its worth: one example is the all-electric Steer-by-Wire steering system, for which ZF has received customer orders from all major world markets. The cubiX chassis software or the first-generation 800-v electric drive will also be used by automotive manufacturers from Asia, Europe, and America in their vehicles in the coming months.

zf.com

Kollmorgen

EXPANDS EXPLOSION-PROOF
SERVOMOTOR LINE



Kollmorgen has announced ATEX certification and IECEx/cETLus listing for the explosion-proof Goldline EBH 480 Vac servomotor. These new explosion-proof approvals for the high-voltage Goldline EBH servomotor exemplify Kollmorgen's commitment to advancing the state of the art in motion control and meeting the most demanding application requirements.

The high-voltage Goldline EBH servomotor joins a broad selection of Kollmorgen explosion-proof motors certified and listed according to UL, ATEX, IECEx and/or CSA standards. Explosion-proof motors are required in hazardous locations where flammable gases, mists or vapors may exist in explosive or ignitable concentrations. Such environments are often found in mines, oil & gas refineries, textile mills, and industrial paint booths.

For high-voltage applications in

hazardous locations, Goldline EBH servomotors offer speeds up to 7,500 rpm with exceptionally high torque density for maximum performance in a minimal installation footprint. Rugged resolver feedback and a built-in thermostat support reliable operation under harsh environmental conditions.

Goldline EBH servomotors in frame sizes 1-6 join other explosion-proof motors in the Goldline EB family that meet ATEX/IECEx standards, and more specifically CE 0081 Ex II 2 G Ex d IIB T3 Gb $-40^{\circ}\text{C} \leq \text{Ta} \leq 40^{\circ}\text{C}$. This classification indicates that the motors are suitable for use in any above-ground industry where easily ignited gases such as ethylene are likely to be present in the atmosphere for 10 to 1,000 hours/year during normal operation (Zones 1 and 2). Kollmorgen applies a flameproof method of protection to the motor so that any internal ignition is contained within the motor housing without the possibility of escape into the external atmosphere. The maximum surface temperature of the motor under fault conditions is 200°C .

kollmorgen.com

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As engine manufacturers began to produce engines which conform to modern emissions standards, many familiar features of the previous generations were casualties of the design process. One such example was the reduction of pump pad provisions provided on the diesel engine itself. Drilling

rig manufacturers who depended on these pads to drive hydraulic pumps for their top drive found themselves facing a costly dilemma: the flywheel of the diesel is needed to provide power to a multispeed transmission to run the draw works, and so a separate hydraulic power unit would need to be used to run the pumps. The cost and space requirement for another diesel engine would significantly increase the price of their machinery.

Enter the Transfluid MPD (multiple pump drive): an innovative split drive module designed to sandwich between the main diesel engine and transmission. It features an integrated flexible coupling on the input side and an SAE standard flywheel and housing on the output side. Gear driven PTO heads provide multiple pump pads for mounting pumps, while the output flywheel ensures adequate power transfer to drive larger transmissions. With this solution, even the most hydraulically impaired engines can cost effectively drive multiple implements. Even hydrostatic equipment can benefit from the MPD's design by allowing each pump to have its own head and be installed without stacking, which greatly simplifies maintenance.

The MPD is available in all SAE standard input/output arrangements, for engines up to 1,850 hp. Up to four total PTO heads are available, with up to eight total pump pads ready for mounting. The pads are not limited to only hydraulic pumps and are able to drive any SAE standard equipment, with adapter kits available for any input configuration. Additionally, Transfluid offers stub shaft PTO attachments for the heads to allow pulley drives (in the case of a side-mounted compressor or generator), as well as oil or air actuated clutches for engaging or disengaging individual pads. As part of the package, the pump circuit for providing pressure to the clutches can be mounted onboard the unit to allow the customer to engage the clutch with a simple 12 or 24 vdc signal. The cooling for the unit can also be routed through the customer's existing heat exchanger, making the MPD a true "drop-in" solution.

transfluid.us

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Rollon has introduced its TLS Series of telescoping linear actuators. The new series is designed to maximize productivity for applications where space is limited—especially for applications with minimal vertical clearance, such as between the machine and ceiling, or horizontally between machines.

TLS telescoping actuators integrate seamlessly into multi-axis systems and are available in two- or three-stage versions. Their telescopic design enables long stroke lengths with minimal closed lengths. The TLS Series features a synchronized drive system, requiring only a single motor to achieve motion. Additionally, these actuators are equipped with a built-in automated lubrication system, ensuring a prolonged lifetime while requiring minimal maintenance.

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- Repeatability as low as ± 0.05 mm.

Rollon's TLS Series actuators' unique combination of high stroke to closed length ratio, synchronized drive system, simple mounting, and minimal maintenance requirement empowers designers to easily optimize their machine footprint or floor layouts for a wide range of industrial equipment including CNC, part transfer, and assembly machinery.

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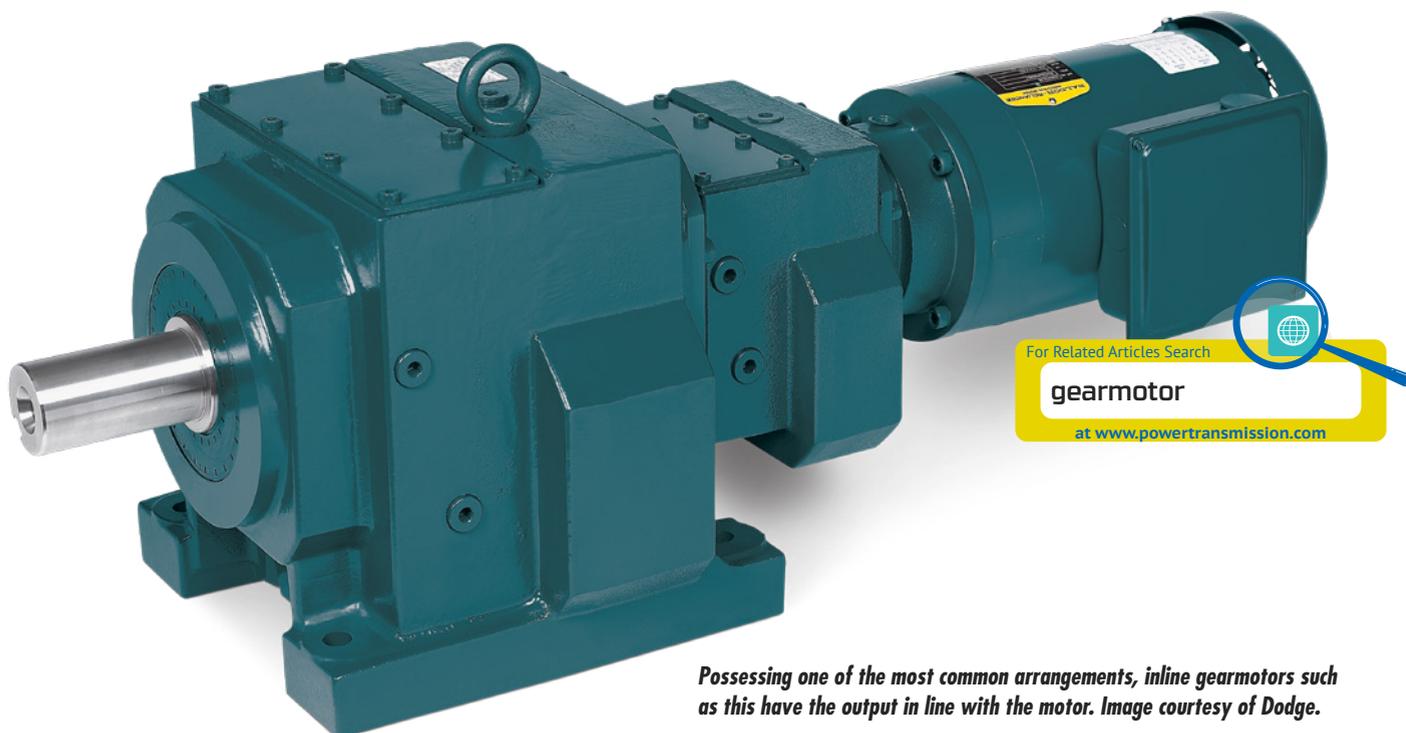
A Guide to Gearmotors

10 Considerations for Long and Efficient Life

Tim Tiebert, Motion

Packing significant efficiency in its relatively small size, an electric gearmotor combines an electric motor with a gear reducer to decrease the motor speed and increase torque available at the gearbox output shaft. Gearmotors are used in processes to produce, manufacture, convey, package and store products used every day and are used frequently in small packaging applications due to their compact size. These units need care via preventive maintenance just like any asset used on a production site.

Our focus will be on general-purpose applications and the choices to best provide a long and efficient gearmotor life. Specific applications require additional consideration and ongoing maintenance.



Possessing one of the most common arrangements, inline gearmotors such as this have the output in line with the motor. Image courtesy of Dodge.

What are the criteria for selecting the right gearmotor for the application? The main considerations are summarized below:

- Speed output
- Torque output
- Application running requirements and duty cycle
- Output configuration
- Output orientation / mounting position
- Environment
- Gear reduction selection
- Lubrication
- Gearmotor control requirements
- Design

1. Speed Output

What speed or speed range is required for the application? If the gearmotor is used to run a conveyor, the required conveyor feet per minute must be calculated through the drivetrain to determine the required gearmotor output rpm. If the gearmotor is controlled by a variable speed drive, the speed range of the gearmotor rpm required will need to be used for the design.

2. Torque Requirements

Torque is the force necessary to move a load. On a conveyor, the torque can be calculated based on the maximum load of material on the conveyor and the properties of the conveyor design. The gearmotor must have the torque output required to start and move the conveyor belt and material at the appropriate speed.

Torque demand is also an important consideration. Does the gearmotor see a high-loading situation at startup? Does the load have an impact or shock requirement to be considered? High starting load and/or shock/impact load will require additional service factors or other gearmotor design considerations for long life.

3. Application Running Requirements and Duty Cycle

What is the gearmotor's required operating profile? Does it operate 24 hours per day and 7 days per week, or 8 hours per day and 5 days per week, or intermittently? Does the gearmotor operate a cyclic load such as an indexing conveyor? Understanding these factors and duty cycle, i.e., the time on and time off required, is necessary to select the right gearmotor.

Loads with high duty cycle, shock load, extreme operating temperature, and vibration should be addressed when selecting the solution. A higher class and service factor will offer mechanical design compensation to accommodate these load factors.

4. Output Configuration

How will the gearmotor transmit the speed/torque to the load? Gearmotors can be provided with a hollow shaft, allowing the driven shaft to be inserted into the gearmotor output. A solid output shaft with a keyway is also common for mounting a sprocket and chain, pulley, and belt, or coupling to the load.

The output can also use a flange to mount the gearmotor to the load. Other configurations may have feet and be mounted on a base connecting to the load through the coupling, belt/pulley, or chain/sprocket.

5. Output Orientation Mounting Position

Where will the gearmotor output be oriented compared to the motor? The most common arrangements are inline and right angle. An inline gearmotor will have the output in line with the motor (see photo, page 14), while the right-angle version may have the output to the right or left, up or down when compared with the motor position. The mounting position refers to how the gearmotor will be mounted: will the feet/body be up, down, right or left? The mounting position must be known when selecting to ensure the internal lubrication is properly oriented for the gearing.

6. Environment

What are the environmental characteristics of the gearmotor location? Is the area inside, outside, clean, dirty, dusty, or wet? Is the atmosphere corrosive, hazardous, or requiring an explosion-proof (XP) rating? What is the ambient temperature range at the gearmotor's location?

Gearmotors are available in different enclosure types, including open steel units for clean areas, totally enclosed units with protective coatings, and stainless-steel construction. Explosion-proof units must be specified based on the XP environment and installed/operated per the area code requirements.

Ambient temperature considerations may result in using different lubrication and grease for the temperature range. The right design will ensure long operating life. Extreme temperature environments include freezers, ovens, foundries, and furnaces.

7. Gear Reduction Selection

Gearmotor gearing types vary in design and efficiency, including planetary, helical, worm and others. Each gearing type provides differing levels of efficiency and is related to the configuration of the gearmotor (right angle, inline, shaft mount, etc.).

In general, the higher the efficiency, the longer the life expectancy. Choosing the highest efficiency gearing means less heat generated during operation and lower mechanical interference, translating to longer gear life, lubrication life and system life.

Some applications require a specific type of gearing to provide the needed load characteristics. These application load considerations include backlash, positioning, impact, and duty cycle.

8. Lubrication

Various lubricants are available for gearmotor gearing. The two main types are mineral oil and synthetic-based lubricants. The lubricant's purpose is to coat contact surfaces, reduce friction and transfer heat away from the gearing.

The correct lubricant characteristics depend on the application. Lubrication varies by viscosity and additives depending on temperature, gearing and application requirements.

Choose synthetic lubricant for the longest life and best lubricating properties. It will provide the best reliability for your gearmotor, along with regular preventive maintenance checks to ensure the lubricant is functioning properly and at the right level. The lubrication must be changed at the recommended interval to maximize the gearmotor's life.



Used in a foam recycling mixer application, this gearmotor features a C-face to protect the motor from the oil and to provide a dry connection between the motor and the gearbox. In case of a motor failure, the facility can swap the motor without touching the gearbox. This unit has a speed output of 15 rpm and a torque output of 115,000 lb.in. Image courtesy of Motion.

9. Gearmotor Control Requirements

AC gearmotors are typically run with variable frequency drives (VFDs), soft starts or motor starters. DC gearmotors usually run with a DC drive. AC VFDs and DC drives offer the best control of the gearmotor.

A variable frequency drive will provide controlled starting acceleration, varying speed control, and controlled deceleration. This control reduces motor starting load and mechanical shock to the gearmotor and the load. Drives also provide speed control with the capability to match the load speed to process flow and maximize system efficiency.

Operating speed range is important when selecting the right gearmotor and drive. Motors vary in their capability to run on a drive. Some AC motors are not rated for operation on a VFD. Their construction may not allow for proper cooling under full speed or provide insulation rated for VFD operation. Consider the speed range required for the application and confirm that the gearmotor is rated to run the highest and lowest speeds needed on a drive.

Soft starts are an option for AC gearmotors. A soft start limits the power available to the motor during the acceleration, taking more time to reach full speed. The “soft starting” reduces the mechanical starting shock on the load and gearing, improving system reliability.

In contrast to a VFD that can change the running speed, the soft start will run the motor only at full speed. A soft start with an integral run/bypass contactor will disengage the soft start power electronics when running at full speed. This helps extend the life of the soft start. Ensure the soft start is rated for the starting characteristics of the load and duty cycle.

Motor starters are an option for AC gearmotors that provide full-voltage across-the-line motor operation. The motor will start as quickly as possible and run at full speed. Motor starters are a simple, cost-effective control choice. However, the quick starting to full speed adds wear to the gearing and load.

10. Design

At their core, gearmotors are a combination of a gearbox and a motor. While some gearmotors are neat, compact packages with the smallest overall length, the manufacturers have designed each piece integral to each other so if a maintenance problem exists, it impacts the whole unit. Another approach is to combine two separate units and make a gearmotor (see photo, left). That is, if one takes a gearbox with a C-face or coupled input and combines it mechanically with a standard NEMA or IEC motor, this design still qualifies as a gearmotor.

Each design (the integral unit vs. the combined unit) has its pros and cons when reviewing their use and application. The compact integral design allows for a smaller footprint and use in tight locations. It also provides for one inventory SKU and requires minimal setup. In contrast, the combined design consists of the gearbox and motor representing two individual SKUs, which can cause mounting issues when a coupling design is used. However, if one piece of the unit fails, it can be replaced quickly as the separate parts are more readily available, and only that section is required. Both gearmotor designs provide similar performance, yet their mounting requirements and availability could impact which makes the most sense for the application.

In summary, gearmotors are critical components of operations throughout industry and can provide years of efficiency with the right choices and planning. Understanding and accounting for an application’s load characteristics combined with the topics addressed above can help to provide a lasting solution when applying gearmotors. It may be wise to have a third-party specialist review the application and give additional insight, but the information in this guide will be a good start.

motion.com/pte

PTE



Tim Tiebert is an electrical specialist at Motion. He has worked in automation and engineering for over 40 years, with 25 at Kaman Distribution and 15 as a project and plant engineer in the food industry. His expertise covers automation, industrial control, power transmission, electrical engineering, and control systems design.



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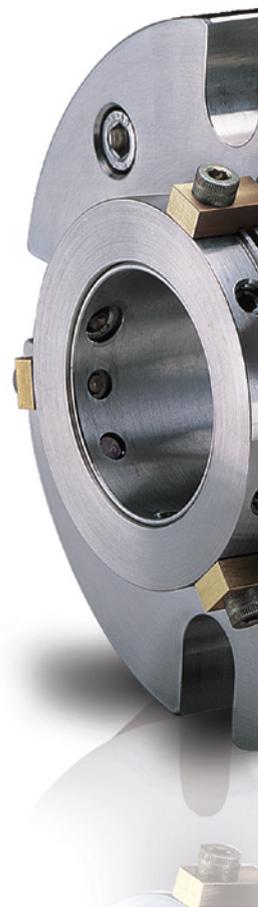
A Closer Look at TPS 2023

Booth previews to help plan your visit

Aaron Fagan, Senior Editor

The Houston Turbomachinery & Pump Symposia (TPS) began as a 200-person Turbomachinery Symposium on the campus of Texas A&M University in 1972. The Pump Symposium was founded in 1984 and joined forces with Turbo to become a combined event in 2011. TPS, still organized by the Turbomachinery Laboratory at Texas A&M University, will gather for the 52nd Turbomachinery and 39th Pump Symposium annual event from September 26–28, at the George R. Brown Convention Center in Houston.

TPS is a vital industry event that offers a forum for the exchange of ideas between rotating equipment engineers and technicians worldwide. For over 50 years, TPS has been known for its impact on turbomachinery, pump, oil & gas, petrochemical, power, aerospace, chemical, and water industries through two pathways: the technical program and the exhibition. Here is a selection of booth previews to help you plan your visit.



AGMA—Booth 1501

Power Transmission Engineering and *Gear Technology* magazines will be exhibiting in the AGMA booth. Stop by and see us to learn more about subscribing, advertising and contributing. Also learn about the value of AGMA membership and participation in our numerous educational, networking and technical events serving the power transmission industry.

A.W. Chesterton Company—Booth 2647

For 140 years, Chesterton has been a world leader in helping process industry companies and manufacturers improve the reliability and efficiency of their rotating, stationary, and fluid power equipment platforms.

Chesterton will be showcasing Pump Repair Services at TPS2023. Chesterton’s team of machinists, technicians, engineers, and millwrights provide the best

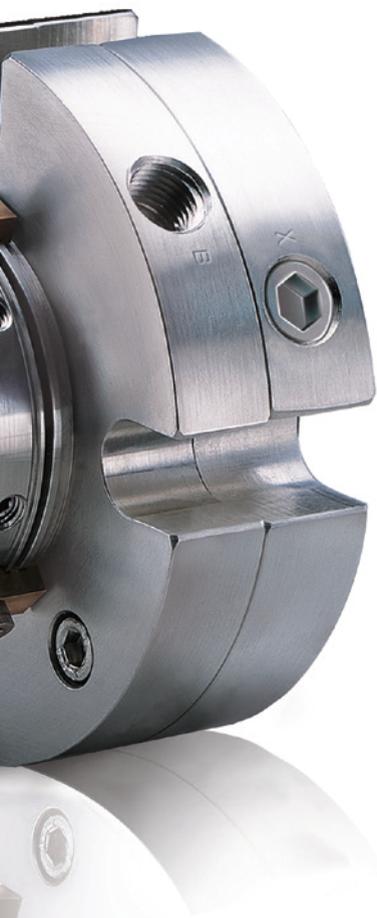
repair and upgrade solutions such as machining, welding and balancing on a wide variety of pumps to increase longevity and performance.

Chesterton will be featuring the 4400 Dual Concentric Gas Seal. Designed for ANSI/API pumps, mixers, compressors, and blowers, The 4400 Gas Seal provides zero fugitive emissions sealing with

minimal barrier gas consumption. Due to the efficiencies of the dual concentric design and the In-Gland Control System, only a fraction of the overall gas consumed is introduced to the process. The remainder of the gas introduced to the seal is transferred to the atmosphere after performing the critical function of face separation.



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Chesterton 442 Split Seal features a factory split design ideal for equipment that is difficult and time-consuming to disassemble, such as large vertical and horizontal split-case pumps. The seal is assembled without adhesives, allowing for easy installation. The 442 Split Seal can be maintained in the field with low-cost repair kits, which reduce ongoing maintenance costs. The compact design of the 442 Split Seal can be used in a wide variety of equipment and process fluids.

Chesterton DualPac 2212 is a high-performance, non-staining, multipurpose braided packing that requires fewer gland adjustments than traditional packing. The packing's shaft side is made from highly resilient fiber that is burn-resistant and long-lasting, which minimizes shaft scoring. DualPac 2212 can be used in the following applications: ore slurries, mineral handling slurries, dewatering, stock, sludge, slurry and process pumps, agitators, and mixers.



SpiralTrac Environmental Controller throat bushing.

The SpiralTrac Environmental Controller is a throat bushing engineered to transform and control the internal stuffing box environment in rotating process equipment to reduce downtime and extend equipment life. SpiralTrac enables particulates to be removed from the stuffing box and away from packing or mechanical seals and permits air to evacuate the stuffing box upon flooding to retain cooling. Heat buildup is minimized in the stuffing box creating circulation around seal faces. SpiralTrac is offered in four configurations: split, adapter, standard, and packing.



Chesterton Connect Equipment Monitoring System.

The Chesterton Connect Equipment Monitoring System monitors and analyzes equipment health 24/7. The Connect sensors and gateway automatically collect and transfer the equipment operating conditions in near real-time to the Chesterton Connect Cloud dashboard, simplifying remote monitoring of equipment to help improve operations.

ARC Industrial Coatings provide long-term protection to systems and equipment exposed to erosion, corrosion, and chemical attack. ARC coatings are ceramic-reinforced and abrasion-resistant and can handle 100% solids and high-temperature.

chesterton.com

ABB—Booth 2835

ABB will present key examples of its full range of energy-efficient Baldor-Reliance motors at TPS. ABB products are engineered with industry-proven designs that reach new levels of efficiency under the most demanding conditions.

ABB offers a wide variety of Baldor-Reliance motors to meet specific pumping needs. Repeatable quality in manufacturing and unmatched service makes Baldor-Reliance the most preferred NEMA motors in the industry. The Baldor-Reliance motor showcase will cover a wide offering of explosion-proof and severe-duty motors.

All Baldor-Reliance three-phase motors are designed for inverter duty. The Baldor-Reliance EC Titanium integrated motor/drive is designed for maximum efficiency. These motors are suitable for constant or variable

torque applications while still offering excellent performance across a wind speed load range.



ABB Baldor-Reliance 841XL.

ABB delivers a wide offering of explosion-proof and severe-duty motors including the Baldor-Reliance IEE 841XL with a patented positive lubrication system (PLS), extending motor life in harsh environments. The severe-duty lineup also includes the IEE 841XL vertical P-base motor with IP55 sealing and winding insulation, suitable for inverter use, making this motor ideal for harsh pumping applications.

baldor.com
us.abb.com

Velo3D—Booth 1419

At this year's TPS Conference, Velo3D will be displaying some new turbomachinery parts, including an entire turbopump that was designed by two students from Colorado University Boulder's Aerospace Engineering Sciences program. The turbopump is more than 95 percent 3D printed—everything except the shaft, spacers, and bolts were 3D printed on a single build using a Sapphire XC. The display is a good example of how metal 3D printing can democratize the design and manufacture of turbomachinery parts, as even two students can have their designs manufactured, finished, and tested.

Sid Raje on the Velo3D team will also be presenting on the functional benefits of additively manufactured turbomachinery impellers. Sid works closely with Velo3D's customers in the turbomachinery industry to help them with the designs and build of

their inducers, impellers, volutes, and other turbomachinery parts. He'll be discussing how 3D printing can help produce more performant designs, streamline supply chains, shorten lead times, and in some cases even lower production costs compared to conventional manufacturing.



This rocket turbopump was printed in Inconel (IN718), a precipitation-hardenable nickel-based superalloy known for its superb tensile strength when subjected to extreme pressure and heat.

In addition to the turbopump (pictured), Velo3D's booth will also have a number of turbomachinery parts on display, including a shrouded impeller produced on its Sapphire XC printer, which is capable of printing parts up to 600 mm in diameter.

velo3d.com

Ingersoll Rand—Booth 2635

With over 145 years of knowledge and expertise, Ingersoll Rand is a global manufacturer and distributor of unrivaled compressed air

and gas solutions, parts and accessories, and service solutions for a wide range of industries and applications. For decision-makers seeking a robust and energy-efficient compressed air system for oil and gas compression in critical industries, Ingersoll Rand offers a wide portfolio of state-of-the-art products. This includes the new MSG

NX 30000 Centrifugal Air & Gas Compressor that meets the demands of energy-intensive sites while making a substantial difference to a business's bottom line, through a range of proven technologies and features. Designed with air separation and industrial gas applications in mind, Ingersoll Rand's MSG NX 30000 centrifugal compressor provides industry-leading efficiency and lower overall total cost of ownership in an optimized, easy-to-maintain package.

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Ingersoll Rand's new MSG NX 30000 centrifugal air and gas compressor.



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Cincinnati Gearing Systems — Booth 2243

Located in Cincinnati, Ohio, Cincinnati Gearing Systems (CGS) is a recognized leader in precision component gear manufacturing and design engineering. More than just a gear manufacturer, CGS offers customers over 100 years of experience in producing high-quality, reliable, and cost-effective component gearing and gear units for a wide range of power transmission applications. Configurations include epicyclic gear units, multiple pinion gear units, parallel shaft designs, vertical and horizontal offsets, dual and single input, single and double helical, and hybrid designs. CGS has in-house full-service manufacturing, design engineering, testing, and heat-treating capabilities. Whether it is a clean-sheet design or a standard design, CGS is the single source to satisfy your specific gearbox requirements.

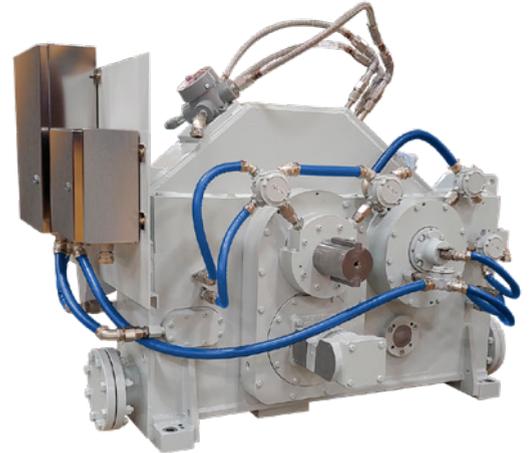
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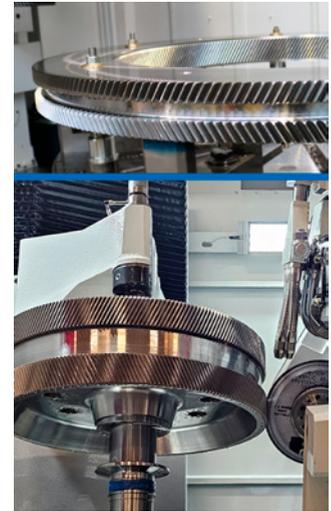


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With the installation of the new Liebherr CNC shaper cutter, CGS has significantly reduced the machining time for double-helical gears. This machine doubled previous cutting speeds. The correction measurement in the machine substantially increases the quality of the gear; and due to the electronic helical guide, CGS can shape every helix angle without the need for additional tooling.

The new Kapp Niles gear grinder has automatic onboard checking and the capability to grind internal gears up to a 30-degree helix angle both left hand and right hand.

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Five Crucial Steps to Minimize Wear and Tear of Motion Components

Limble CMMs examines safety parameters for mechanical systems

Bryan Christiansen, Founder, Limble CMMS



Combating wear and tear of mechanical parts enhances their performances, extends asset lifespan, and maximizes occupational safety and health.

Mechanical motion components are vital machinery parts for power and motion transmission. These components are available in different forms and sizes depending on the desired motion control or extent of power transmission. Components like bearings, motors, gear drives, shafts, belts, and couplings should retain acceptable tolerances for various mechanical systems to achieve their desired performance levels.

Mechanical motion components, though relatively small, contribute immensely to the safety of multiple systems like automobiles, manufacturing systems, elevators, water treatment facilities, etc. Motion components experience wear and tear over time caused by:

- Friction as motion surfaces come into contact with adjacent components.
- Corrosion due to exposure to chemicals, humidity, and corrosive gasses
- Fatigue emanating from repetitive stress and strain.
- Improper lubrication and system overloads

Wear and tear gradually weaken the structural integrity of mechanical components, manifesting as microscopic surface and subsurface cracks, erosion, and visible physical damage (like bends or warping). It can result in extensive machinery damage and workplace injuries. Here are different ways to combat the degradation of mechanical motion components.

1. Apply Proper Lubrication

Poor lubrication exacerbates frictional wear and tear of mechanical components. This increases the frequency and severity of mechanical failures.

To minimize wear and tear companies must prioritize the monitoring of lubrication in mechanical motion components and select the correct grade of lubricants for specific applications. Lubricants create thin films between moving parts, lowering surface friction and thus increasing the performance of mechanical systems and their effective lifespans.

Applying proper lubrication reduces the damage to mechanical motion components by:

- **Minimizing friction between surfaces in contact:** Lubricants ensure these components move without rubbing against each other. Take an example of a planetary gearbox used to transmit torque in industrial machinery. Such a system requires frequent and adequate lubrication to minimize power losses due to friction between moving parts. The amount and type of lubricant depends on the operating speed and loading conditions. Too little lubrication and the protective layer will be too thin to combat surface friction. On the other hand, excessive lubrication results in a viscous drag which causes undesirable power losses.
- **Reducing heat due to friction between moving parts:** Friction between mechanical motion parts generates heat. This heat causes regular expansion and contraction of mechanical components, causing surface damage and distortion of parts. Heat can also cause mechanical components to wear rapidly. Lubricants act as a heat dissipation medium to reduce the repetitive expansion and contraction of materials. This can extend the useful lives of components like bearings, gears, and mechanical shafts that experience repetitive motion.

- **Minimizing corrosion:** Lubricants create a thin film that can protect mechanical motion elements against exposure to moisture and other corrosive elements. Lubrication can significantly reduce wear and tear due to the corrosive effects of the immediate environment. This can decelerate part degradation by chemicals and rust. The thin film created by the lubricant blocks contact between metal surfaces and atmospheric oxygen. It prevents oxidation which causes rapid corrosion. Lubricants contain specific corrosion-inhibiting additives to provide substantial protection against corrosive agents in different operating environments.

Identify specific lubrication requirements for every piece of mechanical motion components and choose the correct grade of lubricant. Adhere to equipment lubrication procedures recommended by the original equipment manufacturer or as prescribed on lubricant packages. This reduces costly mistakes in each lubrication cycle, which might negatively affect machinery performance.

2. Conduct Regular Preventive Maintenance

Preventive maintenance involves specific activities performed over fixed intervals or based on equipment utilization levels. Scheduled maintenance activities should be conducted even if assets are operating as intended. The goal of a preventive maintenance program is to minimize the probability of equipment breakdowns and frequent downtime that lowers the efficiency of mechanical systems.

Some common preventive maintenance activities include:

- Equipment inspection
- Routine cleaning
- Lubrication
- Equipment calibration
- Replacing critical components like belts, bearings, or couplings
- Exercising or testing less frequently utilized equipment.

Establishing and sustaining a preventive maintenance program for mechanical motion elements takes time and requires substantial financial investments. It begins with auditing facilities to identify machinery maintenance needs and define respective maintenance schedules. The schedule outlines daily, weekly, monthly, and yearly maintenance tasks.

Given the sophistication of modern machinery, it may be necessary to invest in digital maintenance tools to complement planning and maintenance evaluation. There are multiple scalable preventive maintenance solutions to cater to different grades and types of mechanical motion components.

Conducting regular preventive maintenance reduces the degradation of mechanical components in several ways:

- Regular inspection using digital tools like non-destructive techniques (infrared thermography or vibration analysis) allows maintenance teams to identify underlying machinery defects. That way, they can

unearth early signs of wear and tear and rectify them before they cause extensive damage. This is crucial for protecting equipment or systems they are used in.

- Routine cleaning removes dirt and contamination around mechanical motion elements. Cleaning ensures agents accelerating damage of motion components are eliminated from processes.
- Preventive maintenance allows technicians to repair and replace damaged components like seals or worn-out fasteners that can accelerate the degradation of mechanical motion components. For instance, a damaged bearing seal will permit water and debris into the bearing cage. These elements increase friction within the bearing, accelerating its degradation.

Consider using digital tools to streamline preventive maintenance scheduling for mechanical motion elements. Create standard checklists to standardize work and enhance workflow tracking. Train technicians to ensure they conduct accurate maintenance at all times.

3. Operate Assets Within Designed Parameters

Every mechanical component has a designed safety limit beyond which its efficiency and safety are compromised. Operating assets beyond their desired capacities increase their susceptibility to wear and tear, leading to premature asset failures.

Improper asset operation occurs when one:

- Overloads mechanical components like conveyor belts
- Utilizes equipment in the wrong environments
- Operates machinery at extreme speeds
- Exceeds the desired pressure and temperature limits

These conditions exert extra stress and strain on mechanical systems. Surface friction, heat, and additional mechanical stresses cause rapid wear of mechanical components.

Adhering to the designed asset operating parameters ensures machinery is utilized for its intended use. It also guarantees proper loading to keep stress and strain on mechanical elements within acceptable limits. That way, assets cannot struggle to achieve their productivity levels.

Mechanical overloads in a milling facility, for instance, emanating from excess torque, can cause irreversible damage to couplings, transmission systems, gear drives and shafts. The overloads can cause the jamming of mechanical motion elements causing further damage due to increased friction.

Companies should outline specific equipment operating conditions based on the manufacturer's recommendations or design parameters. This prevents overloading or wrong process sequences by operators and maintenance teams. That way, companies can eliminate machinery operating conditions causing increased friction between mechanical moving parts.

Proper equipment operation reduces system vibrations, it also reduces the frequency and severity of unscheduled machinery breakdowns. Rapid vibrations create perfect conditions for the gradual degradation of parts. Emergency

breakdowns can create undesirable conditions, like spillage of corrosive fluid media, which can corrode mechanical motion elements. Additionally, maintenance technicians can make errors as they strive to restore assets during emergency breakdowns.

One way to foster proper asset operation is to develop and enforce standard operating procedures. Provide adequate tools and detailed work instructions to ensure employees utilize machinery as intended. Adhering to standard operating procedures eliminates errors that can cause overloading and other undesirable conditions exacerbating wear and tear. Train employees to ensure they understand recommended machinery operating standards.

4. Continuously Monitor Operating Environments

Operating environments have significant impacts on the performance of different mechanical motion components. These components are manufactured from materials with varying physical and chemical properties. Some fabrication materials require strict regulation of environmental conditions.

High temperature, humidity, dust, or corrosive gases can expedite the degradation of mechanical components. Continuously monitoring operating conditions helps companies to identify environmental patterns or trends increasing tear and wear rates.

Companies should monitor the number of abrasive contaminants and develop appropriate control measures.



Monitoring operating environments takes into account:

- **Contamination monitoring:** How many contaminants, such as dust and abrasive debris, are within the working environment? Over time, companies should monitor the number of abrasive contaminants and develop appropriate control measures. Facilities or operations churning out massive amounts of dust can benefit from air filtration systems or dust collectors to protect mechanical motion components.
- **Humidity and corrosion monitoring:** Highly humid environments create perfect conditions for rust on metal components. Companies can utilize dehumidifiers to control the amount of moisture in enclosed spaces. This can reduce premature asset damage through surface corrosion.
- **Temperature monitoring:** High temperature causes thermal stress on mechanical components. Repetitive thermal stresses can lower the efficiency of mechanical motion components since they facilitate the gradual damage of parts. Temperature monitoring can also extend to internal machine parts. Companies can identify assets generating a lot of heat and insulate them or equip them with heat extraction equipment.

Monitor environmental variables over time and implement appropriate mitigation measures before they cause damage.

Invest in relevant industrial sensors, like Internet of Things (IoT) sensors, for real-time monitoring and timely generation of alerts when conditions exceed predetermined levels. Maintain these sensors to enhance their accuracy and durability.

5. Handle Assets Correctly

The way companies handle assets determines the longevity and reliability of mechanical systems. Some practices accelerate the wear and tear of motion components, rendering them ineffective after a short time in service. Facilities require specific procedures for handling, storing, installing, using, and cleaning mechanical motion components. Stocking replacement motion components made from iron or steel in a dusty or humid space causes irreversible surface damage through gradual rusting.

Follow the correct procedures when lifting and transporting mechanical motion components. Use appropriate lifting equipment and hook equipment like motors using eyebolts on its body. Secure these components in the correct packages to protect them from abrasive or corrosive elements during transportation. Do not drop mechanical components from heights to maintain structural integrity and prevent physical damage.

Store mechanical motion components in a clean and dry environment. Indicate on the package if the mechanical parts are fragile. Use the right tools and adhere to recommended procedures during installation. Avoid excessive force when fastening mechanical motion components to avoid breaking, warping, or prematurely damaging them. Verify the alignment of different mechanical parts and check torque specifications when installing or replacing components.

Use appropriate cleaning agents when removing contaminants from assets. Avoid abrasive, tough cleaning tools or chemicals that might distort mechanical motion components or accelerate their degradation.

Final Remarks

Implementing different solutions for minimizing the wear and tear of mechanical motion elements can yield desirable financial savings for any company. Combating wear and tear of mechanical parts enhances their performances, extends asset lifespan, and maximizes occupational safety and health.

Implement best practices and leverage advanced digital technologies to monitor and mitigate equipment degradation. Focus on continuously improving the quality of inspection and maintenance workflows. Collect and analyze equipment performance data to foster a data-driven wear and tear mitigation program, reduce operational costs, and optimize the reliability of mechanical motion components.

limblecmmms.com

PTE



Bryan Christiansen is the founder and CEO of Limble CMMS. Limble is a modern, easy-to-use mobile CMMS software that takes the stress and chaos out of maintenance by helping managers organize, automate, and streamline their maintenance operations.

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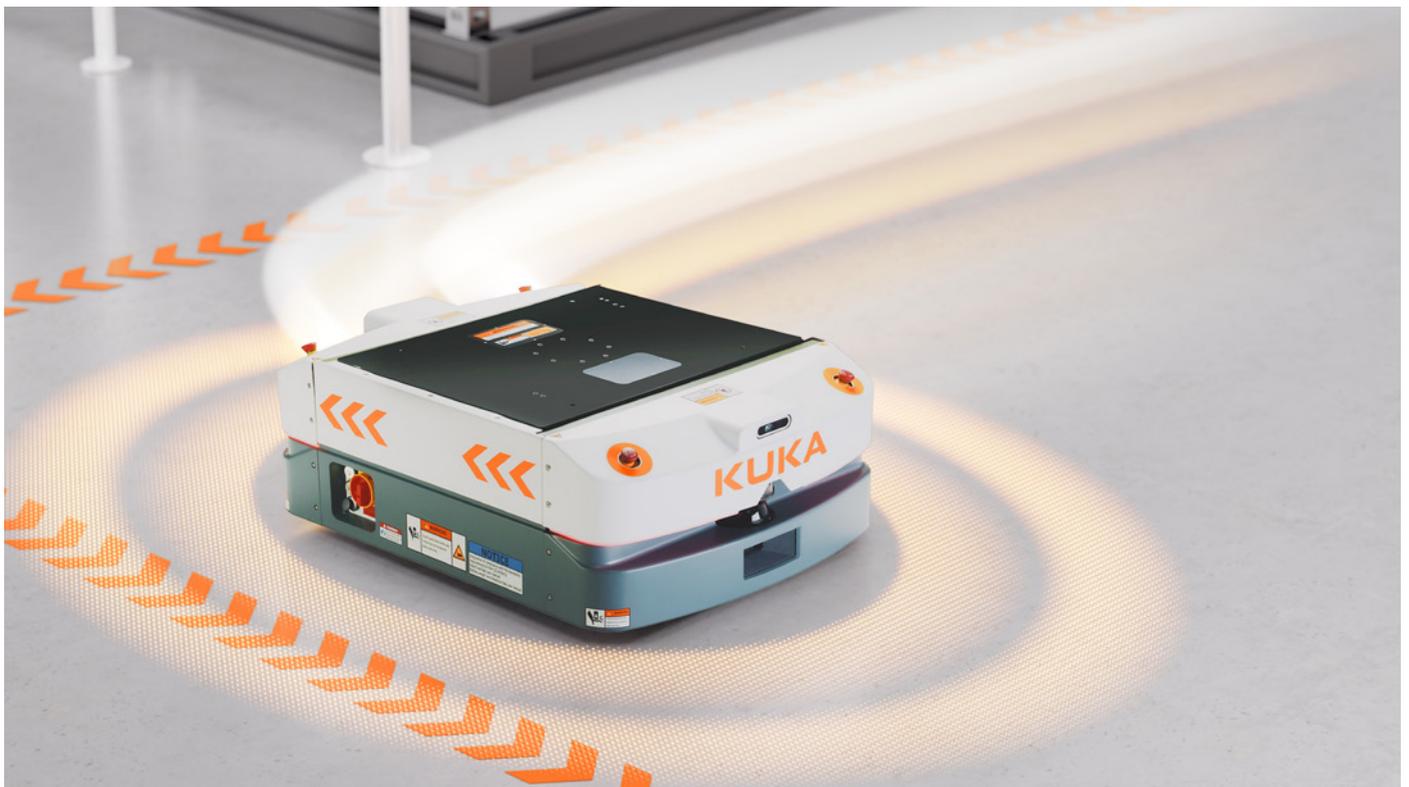
Pack Expo Las Vegas 2023

Highlights automation and material handling technology

Matthew Jaster, Senior Editor

The most comprehensive packaging and processing event in North America this year, Pack Expo Las Vegas 2023 (Sept. 11–13; Las Vegas Convention Center), will be the largest in its history. Produced by PMMI, The Association for Packaging and Processing Technologies, Pack Expo Las Vegas will feature more than 2,000 exhibitors showcasing the newest innovations for more than 40 vertical markets, spanning nearly 1 million square feet of exhibit space.

“We will surpass previous Pack Expo Las Vegas shows this year with more exhibitors and features offered to attendees than ever before. This reflects the growth in our industry as well as the need for our attendees to find new solutions, expand their knowledge, and build their network,” says Jim Pittas, president and CEO, PMMI. “A thriving industry allows for great opportunities as well as challenges—and we’ll be addressing critical issues such as sustainability, workforce, and automation to name a few.”



KUKA Robotics (Booth #C-3236)

KUKA Robotics will showcase various innovative automation solutions for specific handling applications during Pack Expo 2023.

For the handling of primary foods, KUKA, together with integrator Torfresma, will demonstrate the KR3 Delta HM robot in a solution for the primary foods industry. The demonstration exemplifies how KUKA automation provides increased production control while helping food-processing companies reduce operating costs, avoid failures, and maintain high quality standards.

The KR 3 Delta hygienic robot provides outstanding performance and value for pick-and-place applications for the food, packaging, electronics, and pharmaceutical industries. The KR 3 Delta combines precise grip, corrosion resistance and minimal maintenance requirements to excel in sensitive high-speed production applications. This ceiling-mounted robot offers a reach of 1,200 mm, a maximum payload capacity of 3 kg and cycle times as low as 0.5 seconds.

The robot is made from corrosion-resistant stainless steel that protects against dust and moisture. The design accepts alkaline or acidic high-pressure cleaning and disinfection up to 100 kPa for simplified upkeep and shorter downtimes. Food-sector certified for material safety, the entire robot carries IP 67 high-protection certification, with IP 69K for axis 4 that is also ISO 3 rated for cleanroom applications.

To boost the efficiency of product bag handling, KUKA will showcase a cell from Elevation Packaging featuring a KR Iontec robot. Whether on the floor, on the wall or inclined, the KR Iontec combines compact design with the largest working envelope in its class for optimal use of space. Equipped with a waterproof and dust-proof in-line wrist and protected motors, the robot is suitable for almost every area of application.

For those palletizing lines unsuitable for extensive centralized automation, the CUBE cell will show attendees a solution for easy, end-of-line robotic

palletizing. The cell, from KUKA partner FOCUS Integration, features a KR Iontec palletizing robot and is designed for lines where conveyance is too costly or production rates are too low for justifying the investment of a centralized palletizing system.

With a compact and portable 48"x 96" footprint, the ready-to-run CUBE ships on a single platform and installs within hours. The cell's software allows for fast and easy programming of new case sizes along with pallet patterns. Users simply enter case data and select the pallet pattern from intuitive on-screen prompts.

Addressing the needs for easy and efficient mobile automation, KUKA Robotics will also spotlight its recently launched KMP 600-S diffDrive mobile platform automated guided vehicle (AGV) system. The AGV will work with two KR Iontec robots in a cell developed by Mujin for efficiently palletizing and depalletizing consumer goods. To coordinate robot movement, the cell incorporates a Mujin controller and camera system.

The KUKA KMP 600-S diffDrive mobile platform is fast, boasting an operating speed of up to two meters per second, and uses laser scanners and 3D object detection to meet the highest safety requirements, taking industrial intralogistics to new levels. Its payload capacity is up to 600 kg, and the vehicle requires no safety fencing to provide maximum freedom of movement for employees, while laser scanners mounted at the front and rear ensure safe operation at high speeds in all directions of travel when cycle times require it.

For the Fast Moving Consumer Goods (FMCG) industry, KUKA will demonstrate the capability of its Agilus, Delta HM and Scara robots in a pick and place/bin picking cell. Designed to simulate a real production environment, the cell includes KUKA's KR 3 Delta Hygienic robot, KR 6 Scara and KR 6 Agilus robots.

The ultra-compact KR 6 Scara with a 6-kg payload positions at a repeatability of +/- .02 mm. It offers reach/radius options of 500 and 700 mm and a Z-axis stroke of 2 mm. The KR 6 SCARA is strong, fast, highly efficient

and delivers maximum economy. Both robots are paired with KUKA VisionTech that provides powerful tools for 2D object recognition, quality control as well as code and optical character recognition.

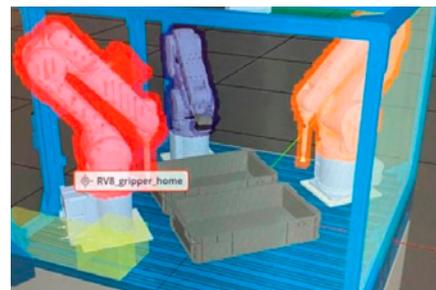
KUKA's KR 6 Agilus in the FMCG cell ensures extreme versatility and agility. Adapting to any installation position, the six-axis KR 6 Agilus is designed for particularly high working speeds, boasts a 10-kg payload, and comes in a wide range of variants for challenging applications such as clean rooms and potentially explosive environments.

kuka.com

Mitsubishi Electric Automation, Inc. (Booth #N-10011)

Mitsubishi Electric Automation, Inc. will be demonstrating automation solutions for consumer-packaged goods and life sciences customers and OEMs. In addition to the Factory Automation Wall, showcasing Mitsubishi Electric's complete line of factory automation products, a new 3D Bin Picking robot demo will be presented. Collision avoidance and dynamic path planning from Real-time Robotics with the newly added 3D Vision from SICK, Inc., will show collision management in a three-robot work cell in this demo.

On Day 2, September 12th at 4:00 pm in the Central Hall on Stage 3—(C-2508), Mitsubishi Electric product marketing manager, mechatronics, Patrick Varley, will be presenting on "The Next Evolution of 3D Bin Picking: Multiple Collision-Free Robots." Alongside Matt Somerville from Realtime Robotics and Nick Longworth from Sick, Varley will discuss how the combination of 3D vision for robotic guidance, dynamic path planning, and collision avoidance can work together to increase throughput and reduce the



footprint needed to deploy Mitsubishi Electric robots.

“While I always look forward to presenting our robots to existing and potential customers at trade shows, I’m especially excited about Pack Expo. The 3D bin picking demo debuting at the show is something that we can’t wait to show to the attendees: three industry leaders, 3D bin picking and three robots,” said Patrick Varley, product marketing manager, mechatronics, at Mitsubishi Electric Automation.

“It’s an exciting time for the robotics industry. The advances in motion control, path planning, and robot vision promise to greatly improve the speed and throughput of logistics operations,” said Matt Somerville, director of sales, North America, at Realtime Robotics. “I’m excited for attendees to see firsthand what the combination of Mitsubishi, Sick, and Realtime technology can do.”

us.mitsubishielectric.com

Emerson (Booth# SL-6107)

Emerson will exhibit its floor to cloud packaging solutions at Pack Expo.

As the future of automation, floor to cloud solutions empower smarter packaging lines and more efficient processes that make it possible for manufacturers to continuously improve plant productivity, sustainability, and safety.

Aventics Series AF2 Flow Sensor



Aventics Series AF2 Flow Sensors have helped plants around the world successfully reduce compressed air consumption and improve energy efficiency. By monitoring air consumption

in pneumatic systems, AF2 sensors enable rapid intervention if leaks occur, helping optimize energy consumption, reach net-zero targets, prevent machine downtime, and reduce costs. Emerson now offers a high-flow model of this advanced sensor that propels compressed air monitoring beyond individual machines to benefit larger air lines and systems. This expanded capability allows users to easily optimize energy consumption across an entire packaging facility and improve overall plant sustainability.

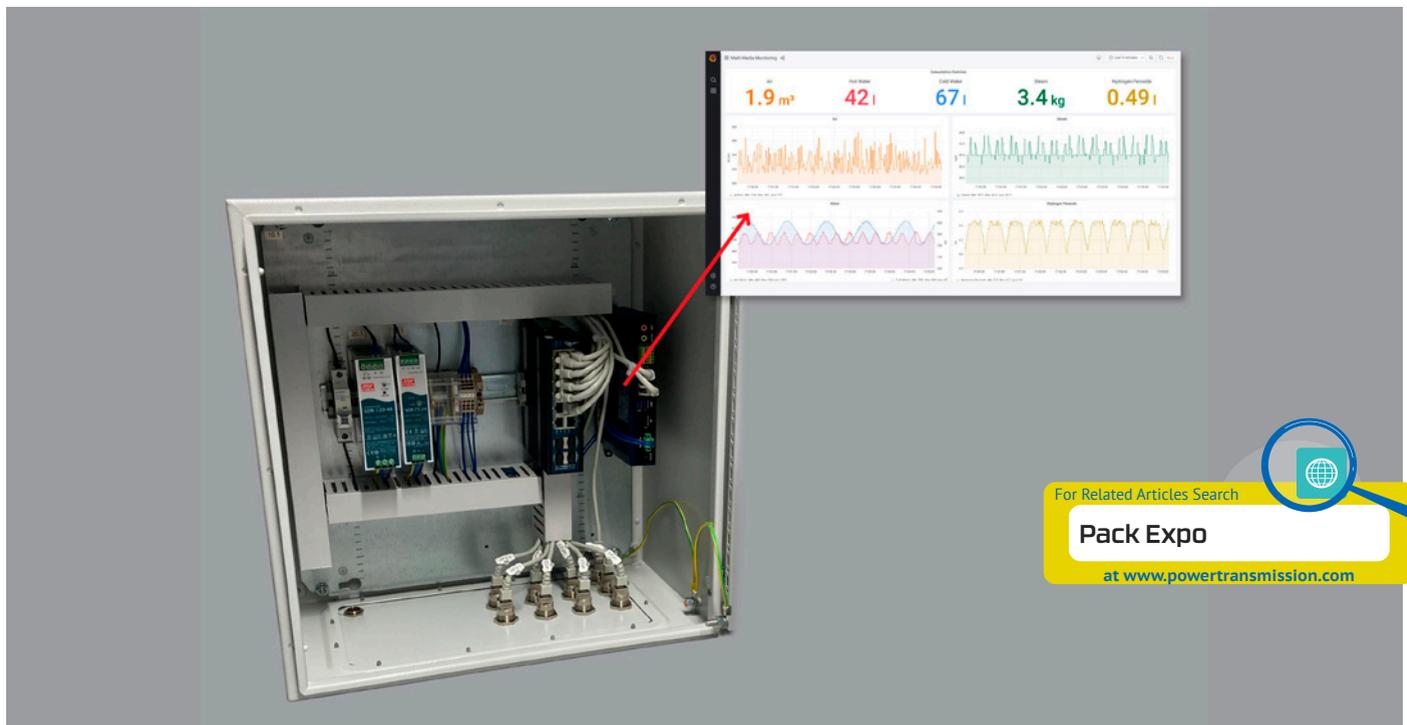
emerson.com/en-us/catalog/aventics-af2

Multimedia Monitoring Solution

The multimedia monitoring solutions (pictured below), including Core-Tigo wireless communication, analyze water, compressed air, gases, electricity, steam (WAGES) and other utilities. The Edge Analytics Dashboard measures efficiency optimizes productivity and avoids or reduces downtime. Emerson experts will demonstrate the multimedia monitoring cabinet solution and the insights it offers, which will support meeting sustainability goals.

emerson.com/Sustainable-Automation

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FEATURE



Efficiency, Engineering & Espionage

The intriguing history behind Schaeffler's
spherical roller bearings

Matthew Jaster, Senior Editor

Spherical roller bearings (SRBs) have a higher load-carrying capacity and are more robust than other bearing products. This is why you'll find them regularly in harsh environments such as mining, construction, and energy applications.

By definition, a spherical roller bearing is a rolling element bearing that permits rotation with low friction and permits angular misalignment. SRBs consist of spherical rolling elements, an outer ring, a cage as well as an inner ring with two raceways inclined at an angle to the bearing axis.

"The development of our bearing products continues on a daily basis," said Martina Lenz, product manager, spherical roller bearings, at Schaeffler. "We're looking beyond mere product improvements by paying close attention to the quality and reliability of the bearing itself."

SRB technology has landed the component in unique applications including high pressure grinding rolls (HPGRs), pipelaying ships, Ferris wheels and even a Cold War-era marine espionage mission.

A Brief History of SRBs

SRBs were designed for systems in which high loads must be supported and shaft flexing and misalignment compensated. They deliver high performance characteristics while carrying extreme loads. SRBs have been improved and adapted to many industrial industries through the years with both FAG (now a brand of the Schaeffler Group) and SKF making key contributions to the technology throughout the product's history.

"In the early days, these bearings were mainly used for transmissions and gearboxes focused on the industrial sector," Lenz said. "In terms of moving into the rolling element aspect, this technology came directly from Schaeffler."

In the renewable energy market, Schaeffler has been developing bearing solutions for on- and offshore wind turbines. Schaeffler technology can now be found in every second to third wind turbine, making Schaeffler a key supplier of wind-sector bearings worldwide. Optimized bearing systems in the gearbox significantly increase the load-carrying capacity and strength of wind turbines.

"The decades of experience our engineers have gathered, combined with innovative ideas, improve our spherical roller bearings even further. As a matter of fact, our quest for perfection in development and production ensures optimum kinematics and low wear, which increases the service life even more," Lenz said.

Replacement work is an additional area where SRBs shine, according to Lenz. Schaeffler split spherical roller bearings are the ideal solution for use in difficult-to-reach locations. Complex tasks can therefore be reduced to a minimum, significantly shortening machine and system downtimes.

Espionage and Intrigue in the Pacific

A phone call came in 1971 to Germany from US engineers on the West Coast with a specific request: They needed FAG Bearings to produce a unique triple-ring rolling bearing capable of meeting extremely strict load, stiffness, and accuracy requirements—10 million lb. radial load, 2 million lb. axial load and the ability to reduce startup friction by 90 percent.

Four of these 2,465 mm, 15.3 ton, bearings would be used in a 40 x 40 ft. marine application gimbal to prevent bending stresses from an intricate network of pipes. The lifting mechanism would be needed to pull large equipment out of deep ocean depths—basically an underwater mechanical claw attached to the ship's surface.

"The triple ring design was intended to help facilitate the 'gyroscopic effect'—as the middle rings turned slowly, the low-friction gimbal could compensate for the pitching and rolling of the ship, so that the mechanism's frame would always be horizontal. This only works with triple-ring rolling bearings," said retired Schaeffler Engineering Manager Heinrich Hofmann, who served as FAG-USA project engineer at the time.

While the components' sheer size and technical data were impressive, it's the application itself that adds excitement and intrigue to the story. The bearing in question was needed for a top-secret, CIA intelligence operation known as "Project Azorian."

The story, courtesy of the CIA Museum, (cia.gov/legacy/museum/), began in 1968 when K-129, a Soviet Golf II-class submarine carrying three SS-N-4 nuclear-armed ballistic missiles sank in the Pacific Ocean northeast of Hawaii. Once search efforts were abandoned by the Soviets, the United States located the submarine about 1,800 miles northwest of Hawaii.

In collaboration with the Department of Defense, the CIA determined the only feasible approach to recover the submarine was to use a large mechanical claw to grasp the hull and a hydraulic system on the ship to lift the vessel to surface.



This is a state-of-the-art "standard" spherical roller bearing as it looks today; this type of bearing is typically used in heavy-duty applications with high radial loads and shaft misalignments.

Unfortunately, lifting a 1,750-ton, 132-foot-long wrecked submarine from 3+ miles (16,500+ ft.) below the ocean surface—under total secrecy—isn't the easiest of tasks.

An elaborate story was put together of a commercial deep-sea mining vessel—The Hughes Glomar Explorer—owned by eccentric billionaire Howard Hughes. This ruse suggested that the ship was simply conducting marine research at extreme ocean depths.

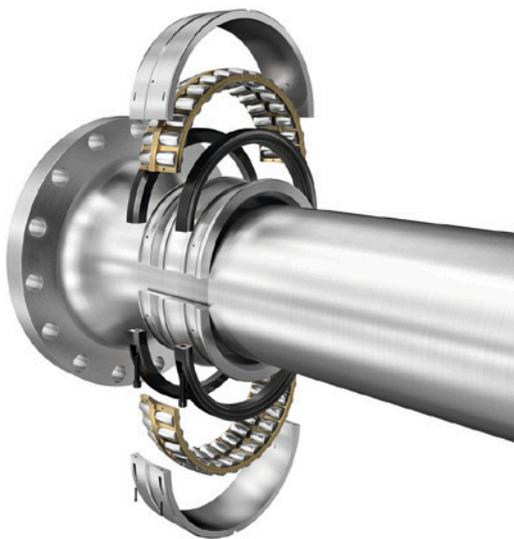
The vessel included a derrick like an oil-drilling rig, a pipe-transfer crane, two tall docking legs, a huge claw-like capture vehicle, a center docking well (called the “moon pool”) large enough to contain the hoisted portion of the sub, and doors to open and close the well's floor.

The heavy-lift operation was extremely complex, according to the CIA museum. While maintaining its position in the ocean currents, the ship had to lower the capture vehicle by adding 60-foot sections of supporting steel pipe, one at a time.

When it reached the submarine section, the capture vehicle then had to be positioned to straddle the sunken submarine section, and its powerful jaws had to grab the hull. Then the ship had to raise the capture vehicle with the section in its clutches by reversing the lift process and removing supporting pipe sections one at a time until the submarine was securely stowed in the ship's docking well.

This mission began on July 4, 1974, while the “commercial mining vessel” was being closely monitored by nearby Soviet ships. Although a portion of the submarine broke apart, the Glomar crew successfully hauled up part of the submarine providing deep insight into the Soviet Union's strategic capabilities at the time.

The intricate, deep-cover operation was deemed one of the most expensive intelligence operations during the Cold War—costing an estimate \$800 million then and roughly \$4.4 billion by today's standards.



Split into halves for easy mounting and dismounting, split spherical roller bearings are mainly used in the aftermarket for quick and cost-effective replacement of conventional “solid” spherical roller bearings.

High-Pressure Grinding Roll (HPGR)

A sealed SRB with a 1,950 mm outer diameter from Schaeffler was used in an HPGR for a mining application.

“The seals prevent the crushing materials from contaminating the bearing,” Lenz said. “The sealed bearing offers significantly longer operating life and can reduce the high cost of unplanned shutdowns.”

As bearing technology evolves, Schaeffler engineers work with their customers in the field to provide additional assistance and bearing improvements.

Until now, HPGR operation has required high quantities of grease to purge contamination from inside the bearings. While necessary, this practice wastes resources and significantly contributes to a mine's preventive maintenance expenditures. By introducing a sealed bearing for this challenging application, Schaeffler's innovation aims to not only provide state-of-the-art solutions, but increase mining productivity altogether.

“Our field engineers inspected these large bearings to determine if we could run the bearing longer or what the maintenance cycle may look like in the future. We're regularly working with our customers in the field to provide feedback and additional maintenance suggestions,” Lenz added.

HPGRs are gaining more acceptance today in hard-rock processing primarily due to their energy efficiency benefits—sealed bearings can assist in making the crushing and grinding circuits much more sustainable in the future.



Sealed spherical roller bearings are designed to keep contaminants out of bearings in manufacturing environments such as mining operations. Schaeffler sealed 241/1250 spherical roller bearings with an outer diameter of 1950 mm operate in one of the world's largest high pressure grinding rolls (HPGRs).

The Apache Maritime Vessel

A pipelaying ship, according to *offshore-fleet.com*, is a maritime vessel used in the construction of subsea infrastructure. It serves to connect oil production platforms with refineries on shore. To accomplish this goal, a typical pipelaying vessel carries a heavy lift crane, used to install pumps and valves, and equipment to lay pipe between subsea structures. Pipe-laying ships make use of dynamic positioning systems or anchor spreads to maintain the correct position and speed while laying pipe. Advancements in technology allow pipes to be laid in water depths of more than 2,500 m.

The Apache 1 was an engineering project that ended up not being produced due to budget constraints, however, Schaeffler was involved in supplying triple-ring SRBs for the Apache II which was built in 1980.

“A different type of triple ring bearing was used for the Apache II. This design consisted of two outer ring halves and one inner ring. The two outer ring halves allowed for zero bearing clearance, which prevented damage to the rollers,” said Martin Grehn, former vice president development roller bearings at Schaeffler Technologies.

They had the pipelines on the land, welded together and the SRBs were ultimately used because of the distance between the components. These triple-ring bearings boasted a 1,750 mm outer diameter, as well as a weight of 6,000 kg.

The London Eye

This Ferris wheel—opened in 2001—is 135 m high, has a circumference of 424 m and a total weight of 2,100 tons. Its 32 capsules carry up to 25 passengers each. The wheel revolves



Featuring three rings and two sets of rollers, triple-ring bearings are mainly used in the paper industry, where they must handle loads and movements in various directions at the same time. A triple-ring bearing was used on the boat that recovered the sunken Russian submarine as part of the CIA’s project “Azorian.”

at a speed of 0.26 meters per second, corresponding to a 30-minute ride for one full revolution—plenty of opportunity to enjoy London from above.

The wheel revolves smoothly thanks to the large FAG SRBs, each of them with an outside diameter of more than two meters and weighing several tons. The two spherical roller bearings were mounted in a locating/floating bearing arrangement in the hub on the axle of the Ferris wheel.

The two large GE440-DW spherical plain bearings from Schaeffler were essential for slewing the wheel from its horizontal mounting position across the Thames into its vertical operating position (slewing angle of more than 90°) with a resulting contact pressure of more than 450 N/mm².

Since then, the spherical plain bearings have had the task of compensating for wind-induced micromovements that would otherwise have an adverse effect on the comparatively stiff steel

construction, according to Jens Fella, vice president research and development, spherical roller bearings and mechanical systems at Schaeffler Technologies.

Thanks to ELGOGLIDE, Schaeffler’s proprietary PTFE sliding layer, the large spherical plain bearings are maintenance-free and can accommodate extremely high loads with low moment levels. This guarantees long life even with contact pressures of 362 N/mm² that are very high for radial spherical plain bearings. If it hadn’t been for the large spherical plain bearings from Schaeffler, a totally different static design would have been required so that the wheel would probably look much less elegant today.

“Although many of our SRBs boast a standard design, we see a growing trend in custom bearings for unique applications like this,” Fella said. “At the time the London Eye opened, it was the largest Ferris wheel in the world. They originally wanted the bearings to run for roughly a year, possibly a year and a half, but they’ve been running without issue for more than 22 years!” Fella added.

A Constant Evolution

As far as the evolution of SRBs in the future, Lenz believes sustainability and energy efficiency will remain the most important factors in the coming years.

“Further lowering friction is going to be the next step. Downsizing options will also play an important role in the future as this industrial trend continues,” Lenz said. “All of the changes we might make will always be designed with sustainability in mind.”

Friction, CO₂ reduction, the green bearing of the future, these are all important customer requests in today’s market.

“If we can provide green components, this will give the customer an opportunity to provide products that are more energy efficient, sustainable and require less maintenance,” Lenz added.

schaeffler.us



PTE

Power Up Your Participation

MPT Expo 2023 offers plethora of training and networking opportunities

Randy Stott, Publisher & Editor-in-Chief



MOTION+POWER
TECHNOLOGY EXPO

October 17–19, 2023 | Detroit, MI

The Motion + Power Technology (MPT) Expo is a three-day show that's designed for the gear and power transmission industry, representing the entire community of professionals involved in the life of a gear, gearbox or other power transmission device—from design to manufacturing, testing, heat treating and more. You can find the suppliers of the equipment to make gears as well as gear and gear drive manufacturers themselves, along with related suppliers of things like software, tooling, lubrication, bearings and more.

Not only is MPT Expo a trade show representing the complete power

transmission supply chain, but it's also an educational and networking event that seems to grow in its offerings with every iteration.

The show takes place alongside AGMA's Fall Technical Meeting (October 16–18), where experts will present research on the latest technology in gear manufacturing. MPT Expo also runs concurrently with the ASM Heat Treat and IMAT shows.

On the show floor itself, you'll have plenty of opportunities to learn and interact with gear-industry colleagues, including live podcasts, exhibitor demonstrations and our own "Ask the Expert" panel discussions in booth #3136.

2023 Ask the Expert Topics

- The Future of Gear Manufacturing (Tuesday 10/17 at 10:30 am)
- Manufacturing Gears for Electric Vehicles (Tuesday 10/17 at 2:30 pm)
- Automation for Job Shops (Wednesday 10/18 at 10:30 am)
- Solving the Skilled Workforce Challenge (Wednesday 10/18 at 2:30 pm)

Panelists for the "Ask the Expert" sessions will be announced soon! In addition, on the same stage in Booth #3136, our editors will be conducting live interviews with many of the exhibitors and other specialists who will be at the show, highlighting the latest technology and solutions for our industry.



Networking Events

FTM Networking Reception

Monday, October 16, 6:00 pm–8:00 pm
\$85. Join attendees from the Fall Technical Meeting (FTM) for a fun networking reception at The Yard in Corktown! The reception is included in your registration for Full FTM attendees, but tickets are available for single session passholders and other MPT Expo attendees interested in fun, games, food, and drinks. The reception includes dinner and fun activities including axe throwing, board games, shuffleboard, fire pits, and cornhole. The reception is included in your registration for Full FTM attendees, but the reception is open to anyone interested in joining the fun!

Women in Manufacturing and Engineering Breakfast

Tuesday, October 17, 7:00 am–9:00 am
\$50. AGMA and ASM are pleased to invite all women at MPT Expo to a networking breakfast where there will be a panel of industry experts sharing experiences and advice about how to become leaders in your field and how to avoid complacency in the workforce to advocate for your own career. Join others from all sectors of manufacturing and engineering, from new employees to high-level executives, to build new relationships, grow your network, and innovate for the future. Who should attend: All women exhibiting or attending MPT Expo, the Heat Treat Conference & Exposition, or IMAT events who want to network and be inspired!

Opening Night Welcome Reception

Tuesday, October 17, 5:00 pm–6:00 pm.
FREE to all attendees. Join exhibitors and fellow attendees on the show floor for the Opening Night Welcome

Educational Opportunities

See the website at motionpowerexpo.com/education-courses/ for information on pricing.

Reception. Your expo pass includes two drink tickets, and hors d'oeuvres will be served. Come meet exhibitors, network with your peers, and meet new friends as we kick off MPT Expo!

Wednesday Networking Reception

Wednesday, October 18, 7:00 pm–10:00 pm

\$100. Take a night off from the trade-show floor to unwind and network with industry professionals! Meet up with old friends or enjoy the open bar with new prospects. Enjoy local fare and drinks and get ready for an evening of fun and entertainment. More details regarding this event will be posted soon! Who should attend: All those attending or exhibiting at MPT Expo, the Heat Treat Conference & Exposition, or IMAT events.

AGMA Electric Vehicle Technology Town Hall

Thursday, October 19, 8:00 am–10:00 am

Free. For more than 100 years, AGMA has led discussions in standards development for the gear industry. From streetcars to wind turbine technology, AGMA has been the facilitator-in-chief bringing together stakeholders to discuss, brainstorm, share, and collaborate in the development of standards that are utilized by entire industries across the globe.

Electric vehicle technology is emerging as a mainstream technology, and to keep within its traditional role as the facilitator-in-chief, it is time for AGMA to gather experts and begin discussion on standards for this space.

The two-hour town hall style meeting will include a discussion on what current AGMA documents are available for use in the EV space. Next, attendees will be invited to share their thoughts on current state of the EV sector including areas and topics where AGMA could step in to support the gear industry. Drawing on its 100+ year experience, the goal of this event is for AGMA to gather the experts around a table to discuss outstanding issues identified by consensus and collaborate on consensus based, mutually beneficial solutions as it relates to the EV sector. Come be a part of the discussion!

This meeting is open to all interested from the gearing industry, specifically those involved in the electrical vehicle space. Participants should expect, and be ready and willing, to collaborate and share knowledge.

Basics of Gearing. Tuesday, October 17, and Wednesday, October 18, 8:00 am–5:00 pm. Instructor: William Mark McVea, KBE+, Inc. Dramatically improve your knowledge and productivity through Basics of Gearing. This course will be presented in a two-day format and will give you a comprehensive overview of standard gearing nomenclature, gear involute geometry, inspection procedures, and much more.

Integration and Trade-Offs in Gear and Bearing Systems. Tuesday, October 17, 8:00 am–5:00 pm, and Wednesday, October 18, 8:00 am–noon. Instructor: Michael Berhan, Ford Motor Company. The purpose will be to cover the concurrent design and analyses of gears and bearings in integrated systems like gearboxes, transmissions, and electric motor drives, so as to allow for good integration and faster optimization of the overall system. This will help gear engineers and suppliers better determine the trade-offs with the bearings, help bearing engineers and suppliers similarly with the gears, and system engineers better understand both. The examples covered are generic but should be useful both within and across industries that use these components and systems.

Reverse Engineering: Why, When, and How—Avoiding Pitfalls and Litigation. Tuesday, October 17, 8:00 am–5:00 pm. Instructor: Raymond Drago, P.E. Reverse engineering a gear system is a not too unusual task and in many, but not all, cases the process goes fairly well, thus it is easy to become complacent. It is important, however, to fully understand the process and the best practice procedure for reverse engineering a gear system. This course will review the basic types of reverse engineering projects. The need for understanding the operation of the system in which the gears will be used, the conditions that led to the need for the project and especially, the specific nature of the failure that occurred, if that is the reason for the project, are key, often ignored, elements of the process.

Why Bearings are Damaged. Wednesday, October 18, 1:00–5:00 pm. Instructor: ABMA. The American Bearing Manufacturers Association is offering this course on rolling element bearings for those involved in industrial equipment design, reliability, and maintenance. It will include a basic overview of rolling bearings, their selection, precision and mounting considerations, service life estimation, and lubrication-related influences. A hands-on damage analysis session will be the featured portion of this program.

Involute Spline Design and Rating. Wednesday, October 18, 8:00 am–5:00 pm. Instructor: Raymond Drago, P.E. This course will address both geometry and rating of involute splines of various types. Types of spline joints and their applications are discussed. Spline configuration variations including half depth and full depth and special function designs will be addressed. Both fixed and flexible spline configurations are treated in terms of usage and design. Lubrication methods, including grease, oil bath and flowing oil as well as coatings appropriate for various spline applications are discussed. Shear and compressive stress rating methods are discussed with analyses methodology presented in both equation and graphical methodology via various rating charts.

Modern Automated Gear Quality Assessment Technology. Thursday, October 19, 8:00 am–5:00 pm. Instructor: William Mark McVea, KBE+, Inc. This course is intended to provide you with a thorough understanding of the information contained within a typical gear inspection report. Specifically, we will look at the contents and meaning of the information contained within the gear charts, as well as the techniques used by the gear measurement system to assess gear quality. An explanation of basic gear measurement techniques, how measurement equipment and test machines implement these techniques, and how to interpret the results from these basic measurements will be covered. We will also discuss how to interpret the results and what corrective actions may be considered if the quality of a particular gear is unsatisfactory.

Materials Selection and Heat Treatment of Gears. Thursday, October 19, 8:00 am–5:00 pm. Instructors: AGMA and ASM International. Because of their unique contribution to the operation of so many machines and mechanical devices, gears have received special attention from the technical community for more than two millennia. New developments in gear technology, particularly from the materials and heat treatment perspectives, have improved gear performance. This course, developed jointly by AGMA and ASM International, will provide an overview of materials selection and heat treatment of gears. Topics covered include: Gear material selection, heat treatment, material hardenability, allow steel selection, gear failure concerns, manufacturing considerations, material form, cast iron, powdered metal, bronze and brass, and plastics.



Figure 1 — Safeco Field (now T-Mobile Park).

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How to Achieve Longer Gearbox Service Life

Sumitomo examines product selection and maintenance techniques

Jesus Teran Dagnino, Sumitomo Drive Technologies

Introduction

In July of 1999 the Safeco Field (currently T-Mobile Park) opened its doors as the new home of the Seattle Mariners (Figure 1). At that time, this first-of-its-kind stadium designed with a retractable roof would allow the Mariners' fans to enjoy the ball game even during inclement weather.

The retractable roof is driven by 96 Sumitomo gearboxes. After over 24 years of service, a Sumitomo gearbox was returned for overhaul. The gearbox's condition is a testament to the importance of careful selection and maintenance, as it demonstrates the exceptional durability and craftsmanship of Sumitomo gearboxes, which can provide reliable operation for many years.

This paper examines the selection process, operation, maintenance practices, and state of the gearbox after over 24 years of operation. It is demonstrated that a quality product and careful consideration of all these factors are essential for a longer service life of the gearbox. Detailed information is provided on the operation of the gearbox, as well as the maintenance practices that should be taken to ensure its longevity. Finally, the paper examines the state of the gearbox after over two decades of use and how all these factors result in lowering carbon emissions.

Product Selection

Based on Sumitomo’s load classification for selection (Figure 2), a service factor (SF) of 1.4 is required for heavy shock load and intermittent duty (3 hours per day) applications. SF is calculated as the capacity of the gearbox divided by the motor power. Considering a 10-hp motor, the gearbox’s capacity should be equal or exceed 14 hp. The Sumitomo gearbox model KHFJS-D4165-R1-62 was selected as it meets all requirements. A breakdown of the application’s requirements is laid out in the following sections.

PRIME MOVER	DURATION OF SERVICE	LOAD CLASSIFICATIONS					
		UNIFORM		MODERATE SHOCK		HEAVY SHOCK	
		AGMA	SM-Bevel Buddybox reducer	AGMA	SM-Bevel Buddybox reducer	AGMA	SM-Bevel Buddybox reducer
ELECTRIC MOTOR	Occasional 1/2 hr. per day	*0.50	*0.50	*0.80	*0.80	1.25	1.20
	Intermittent 3 hrs. per day	*0.80	*0.80	1.00	1.00	1.50	1.4
	Up to 10 hrs. per day	1.00	1.00	1.25	1.20	1.75	1.6
	24 hours per day	1.25	1.20	1.50	1.4	2.00	1.8

Figure 2—Load classification based on Sumitomo’s experience.

Application

The retractable roof is towed by 128 wheels powered by 96 10-hp electric motors (Ref. 1) that travels through rails and wheels similar to those of a train (Figure 3). Under ideal conditions, the gearbox experiences uniform load. However, as the roof is meant to be used during inclement weather, the gearbox can experience heavy shock loads and variable loading due to wind speed.



Figure 3—Retractable roof’s wheel drive.

Ambient Conditions

The gearbox installation is outdoors, which exposes the gearbox to changing weather conditions. The ambient temperature ranges from 35 to 76 °F (~2 to 24 °C), and the relative humidity is within standard limits.

Hours of Operation Per Day

The deployment time ranges from 10 to 20 minutes depending on the speed of wind and other weather conditions (Ref. 1), such as built-up snow that increases both the weight of the roof and the load on the gearboxes. In a worst-case scenario, tests may be conducted to ensure proper operation of the roof, which can result in operating the roof multiple times, with an estimated maximum time of operation of three hours per day.

Output Speed

To safely move the retractable roof’s structure, an output speed of 28.2 rpm was calculated, requiring a 62 ratio at 1,750 rpm input speed. Motor speed and horsepower Based on the demand torque for the application, a 10-hp motor operated at 1,750 rpm was specified.

Mounting Position and Output Connection

The gearbox is mounted horizontally using a flange that bolts onto the structure (Figure 4). It features Sumitomo’s Taper Grip Bushing (TGB), a keyless output connection that eliminates the need for precision machining of the driven shaft during installation (Figure 5).

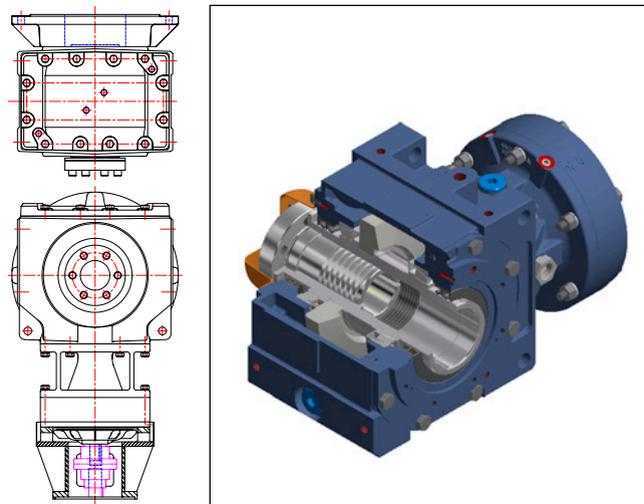


Figure 4 (left)—Flange-mount Bevel Buddy Box in horizontal position. Top: side view. Bottom: back view.

Figure 5 (right)—BBB4 model with Taper Grip Bushing as output connection.

External Radial and Axial Loads

The flange-mounted gearbox supplies only torque with minimal axial or radial shaft loading. Bearings on the output shaft are only subjected to negligible runout. The input shaft uses a C-Face adapter and flexible coupling, resulting in an alignment-free input connection with no radial or axial loads applied on the input shaft.

Operation

From 1999 until 2014, the Seattle Mariners played 1,262 regular season games (Ref. 2) (Figure 6). Even though Seattle has a reputation to be a rainy city, most games were played with the roof open. In this 15-year time period, only 173 games were played with the roof closed, and 104 times the roof was operated during the game. It can be concluded that the roof was deployed for game-related events an average of 18 to 19 times per year. If other reasons are considered (nongame events, field maintenance, roof maintenance, and training), roof deployments may vary from 250 to 400 per year.

The intermittent nature of the roof’s operation helps prolong the lifespan of the gearbox. However, it’s important to note that when the roof is operated in poor weather conditions, it can result in heavy shock loads that put a strain on the gearboxes. To account for this potential overload, the appropriate service factor was carefully chosen.

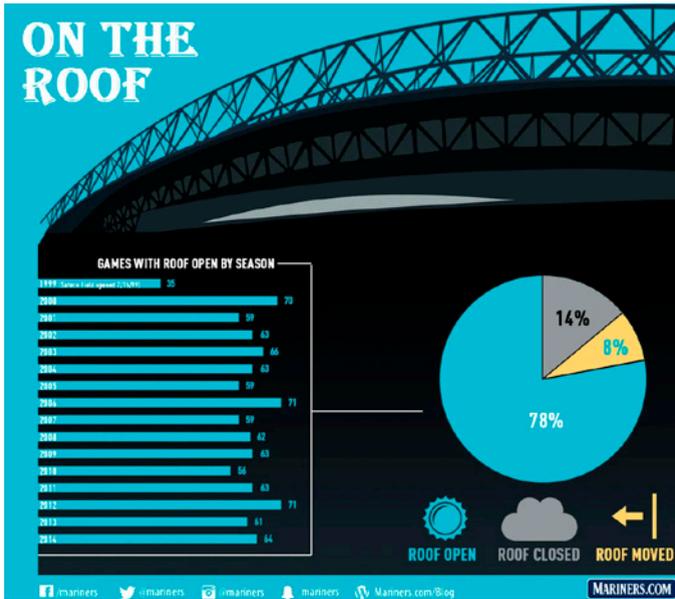


Figure 6—Games with roof open by season from 1999 to 2012 (Ref. 2).

Maintenance

Considering an ambient temperature range of 35 to 76 °F (-2 to 24 °C), it is recommended to use a gear oil with ISO viscosity grade of either 100 or 150 cSt (Figure 7). Mobile SHC 627 oil with viscosity grade of 100 cSt was used in the Sumitomo gearboxes, as this gear oil provides sufficient oil film thickness on hot days and does not affect start-up during cold days.

Ambient Temp.	14°F - 32°F (-10°C - 0°C)	32°F - 95°F (0°C - 35°C)	95°F - 122°F (35°C - 50°C)
Viscosity @ 40°C (104°F)cSt	61.2 - 74.8	90 - 165	198 - 506
ISO Viscosity Grade	68	100 - 150	220 - 460
AGMA Viscosity Grade	2EP	3EP - 4EP	5EP - 7EP
Viscosity @ 100°F 38°C SSU	284 - 347	417-765	916 - 2719

Figure 7: Recommended oil viscosity for SM Bevel Buddybox & Cyclo.

The following practices are performed during maintenance:

- The oil is checked in all 96 gearboxes every 6 months.
- Every time the roof was deployed, maintenance personnel is located on each runway to check for abnormal sounds, odors and leaks.
- If any issues were found, these were reported and addressed in a timely manner.

Sumitomo recommends changing the oil every 5,000 hours or every two years, whichever comes first. T-Mobile Park’s Maintenance Team diligently followed Sumitomo’s recommendation.

Sumitomo Gearboxes Are Built to Last

A couple of gearboxes were found leaking which prompted the Mariners’ stadium maintenance staff to reach out to Sum-

itomo to inspect them. It was recommended by Sumitomo’s Sales team to do a preventive inspection to avoid failure of the gearbox during service. The exterior of the gearbox does not show any defects other than the leakage found on a couple of units (Figure 8). The interior of the components showed only minor wear. The Cyclo reduction components (Figure 9) were found to be in an almost new condition. After over 24 years of gearbox operation, it is likely to find spalling on the eccentric cam or micropitting on the disc lobes. In this case, neither of these two failure modes was found, and the reduction components were deemed reusable.



Figure 8—External condition of the gearbox. Back of the unit, no defects (top). Front of the unit, leakage on low-speed shaft seal and mild rust on the mounting surface (bottom).

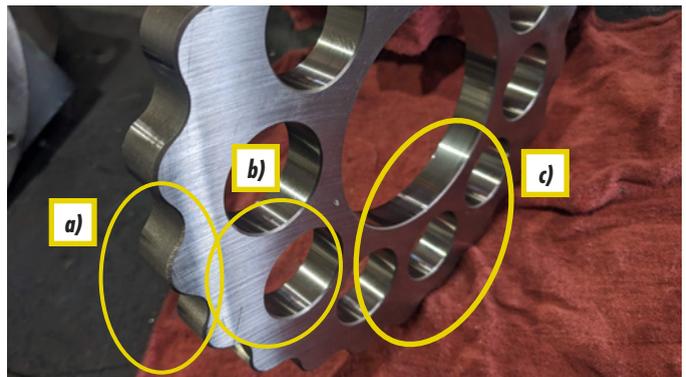


Figure 9—Condition of the Cyclo discs. a) Cyclo discs’ lobes show mild polishing. b) Low-speed shaft pin’s contact surfaces and c) eccentric bearing’s outer race both show mild abrasion.

As for the bevel gears, no failure modes other than minor abrasion was found (Figure 10). The bevel gears usually

operate at lower speeds than the Cyclo portion, so the minor wear will not represent an issue. The bevel gears were also deemed reuseable.



Figure 10—Bevel gear set condition. Bevel pinion shows mild polishing (top), and bevel gear shows mild polishing (bottom).

Aside from checking for the condition of the reduction components, it is a standard practice for Sumitomo’s Repair Team to do an overhaul of the unit. An overhaul would include the replacement of normal wear and tear items such as seals and bearings. Additionally, it was recommended to replace input and output shafts in order to avoid components with minor rust, in order to facilitate installation.

Keeping Your Operations Green

As there is a global awareness over climate, companies are pushing towards reducing energy consumption to reduce carbon emissions. From the gearbox manufacturer’s side, a reliable Sumitomo gearbox, in combination with preventive maintenance practices, can result in reducing energy consumption by avoiding the manufacture and assembly of a replacement gearbox. As shown in this case study, there was no need to either replace the Sumitomo gearbox on this application, nor there was a need to remove it to repair / overhaul any gearbox in over 24 years of use.

As for the driven machine, the precision required in the manufacturing of drive components can lead to longer manufacturing times and increased energy consumption. However, the use of Sumitomo’s Taper Grip Bushing can help reduce the energy consumption used in manufacturing in two ways:

1. No key is required (except for a few specific applications).
2. No special driven shaft tolerance is required.

As a result, commercially available shafting can be used, which removes two manufacturing operations and makes the manufacturing process more energy efficient.

The installation process also affects energy consumption. Sumitomo’s Taper Grip Bushing makes installation quicker and easier by providing greater clearance between the driven shaft and hollow bore, eliminating the need for special tools. Additionally, only a small amount of anti-seize paste is required for dismounting the gearbox, which makes the product more environmentally friendly (Figure 11).



Figure 11—Anti-seize paste used in a minimal surface area for Sumitomo’s Taper Grip Bushing.

Finally, the use of Sumitomo’s Taper Grip Bushing as an output connection reduces the failure rate and increases service time. In contrast, Keyed Hollow Bore installations have a small clearance between the hollow bore and driven shaft, which can result in fretting corrosion due to the rubbing of the driven shaft against the hollow bore. This can damage the hollow bore, driven shaft, and seals, leading to increased failure rates. Thanks to the friction operating principle of Sumitomo’s Taper Grip Bushing, the hollow bore clamps onto the driven shaft, eliminating the risk of fretting corrosion and reducing the energy required to remove and replace the gearbox.

Conclusion

After over 24 years in service, the condition of the gearbox was deemed reusable. Seals and bearings were replaced as it is recommended during overhaul. Input and output shafts were recommended to be replaced in order to facilitate future installations.

The long service time of the gearbox was a result of:

- A deep understanding of the application, resulting on the proper selection of the gearbox.
- The excellence in maintenance practices that are reflected on the condition of the gearbox, as the reduction components are in excellent shape.

Due to the high quality of the Sumitomo gearboxes, rarely, or if ever, any issue was found during the maintenance inspections.

Proper selection and maintenance, in combination with high quality reduction components, are crucial for maximizing the gearbox’s service life and keeping your operations green.

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PTE

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2. Inside the Numbers on the Safeco Field Retractable Roof, <https://marinersblog.mlblogs.com/inside-the-numbers-on-the-safeco-field-retractable-roof-6ff9dea9e955>.

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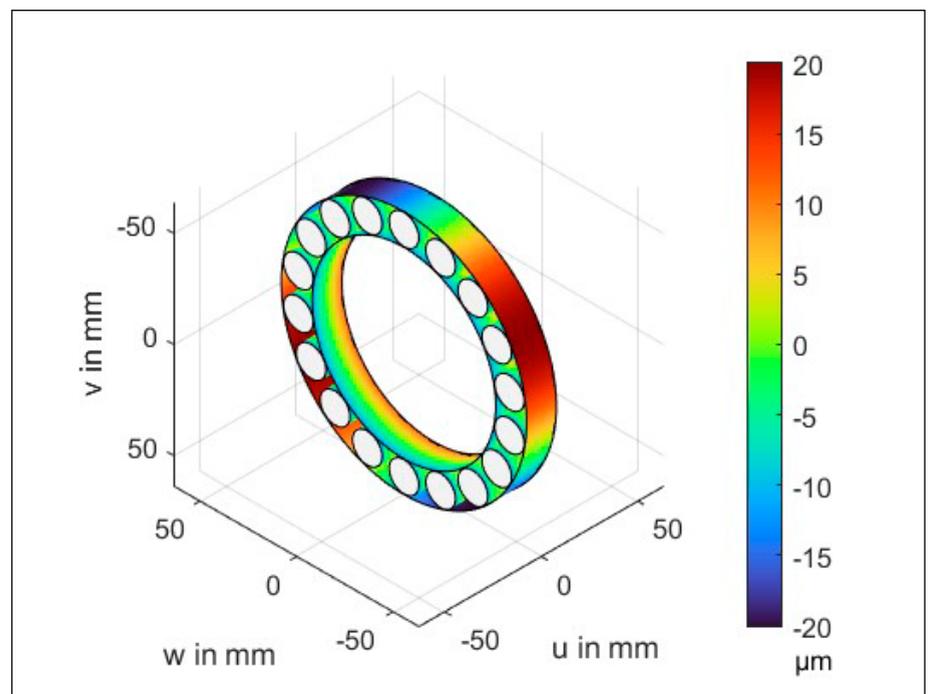
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Rolling Bearing Calculations with Consideration of Geometric Deviations

Vincent Kramer, M. Sc.; Dr.-Ing. Marcel Bartz; Dr.-Ing. Stefan Götz; Prof. Dr.-Ing. Benjamin Schleich; and Prof. Dr.-Ing. Sandro Wartzack

Rolling bearing calculations are usually based on the assumption of ideal nominal geometries. However, actual components and assemblies are always subject to statically distributed geometric deviations resulting from the manufacturing and assembly processes. This leads to changes in the internal geometric conditions which have an effect on bearing characteristics such as the service life. The *FVA-Workbench* makes it possible for users to consider these geometric deviations in bearing calculations for more reliable results.



The raceways of a cylindrical roller bearing with a tapered geometric deviation of the inner ring raceway and ovalization of the outer ring raceway.

Problem Statement

Rolling bearings are indispensable components in all fields of mechanical engineering which allow for precise, low-friction, and cost-effective bearing arrangements for rotating components. Rolling bearings are typically calculated according to ISO/TS 16281. This generally assumes an ideal geometry for the actual raceways with no misalignment of the bearing axes.

However, this ideal situation can never be achieved in practice. The manufacturing and assembly processes always lead to geometric deviations which are expressed as a static distribution (Ref. 2). Furthermore, the loads during operation can cause deformations which influence the operating behavior of the bearings. For example, Fingerle (Ref. 3) has shown that meshing forces acting on the planetary gears cause ovalization of the wheel body. This leads to an increased or reduced bearing life compared to an ideally stiff wheel, depending on the conditions.

The integration of geometric deviations and their statically distributed characteristics in rolling bearing calculations results in a more accurate representation, which leads to improved results.

The *FVA-Workbench* (Ref. 4) software allows users to consider these form and position deviations in rolling bearing designs. The scripting interface also makes it possible to integrate user-defined routines. The following will show how these options can be used to perform bearing calculations, taking these statically distributed geometric deviations into consideration.

Consideration of Geometric Deviations in Rolling Bearing Design

The *FVA-Workbench* can be used for the modeling, configuration, and calculation of transmission systems. When modeling the entire system, an STP file of the casing can be imported, which can be then coupled with the bearing outer ring via a simple click workflow. This makes it possible to calculate the stiffness matrix and determine the equivalent stiffness according to Guyan (Ref. 5) without the use of external FE

software. In addition to using bearing data according to manufacturer specifications (e.g., from rolling bearing catalogs), the rolling bearing geometry can also be directly specified. This includes profiling of the rolling elements and raceways, which makes it easy to consider form deviations.

Deviations on the outer ring raceway can be defined as radial deviations from the ideal circular form. For example, this can be used to define ovalization of the outer bearing ring.

Figure 1 shows an example of form deviation of the outer ring, enhanced one-hundred-fold for clarity.

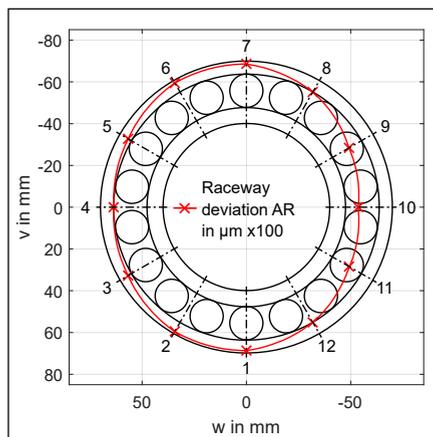


Figure 1—Example of form deviation of the outer ring raceway along the circumference (AR \triangleq outer ring), illustration enhanced one-hundred-fold.

For rolling bearings with line contact, any kind of profiling can be defined in the axial direction for the rolling elements on the inner and outer ring.

Generally, manufacturers use specifically designed profile functions to improve the service life. In theory, however, any kind of form deviation of the raceways can be represented.

Figure 2 shows some example deviations in the axial direction with eight interpolation points. The rolling elements correspond to the suggested profile according to DIN 26281—with a crowned form deviation on the inner ring and a tapered form deviation on the outer ring. These values are also enhanced one-hundred-fold for clarity.

When using the slice model, DIN 26281 prescribes dividing the bearing into at least 30 axial slices. The *FVA-Workbench* supports any resolution, as long as this lower limit is not exceeded. For optimal

resolution of the desired profiling in the slice model, a number of profiling interpolation points at least equal to the number of slices should be selected.

On the outer ring, additive deviations can be overlaid in both the longitudinal and circumferential directions.

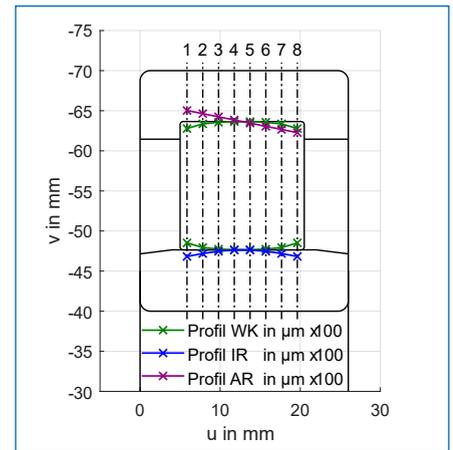


Figure 2—Example of form deviation in the axial direction (profilings) on a cylindrical roller bearing (WK \triangleq rolling element, IR \triangleq inner ring, AR \triangleq outer ring), illustration enhanced one-hundred-fold.

In addition to these deviations on the raceways, an offset and misalignment of the casing-bearing seat can also be defined by specifying values for the vertical (v) and transverse (w) axes (for identification of the axes, see Figure 4). In the calculation, these values represent boundary conditions that are considered accordingly in solving the quasi-static equilibrium in the shaft-bearing-casing system.

The Scripting Module (Ref. 6) can be used to automate complex processes in the *FVA-Workbench*. Simple commands can be used to load additional data, run calculations, and create custom output reports. Possible output formats include simple text files, clearly prepared HTML reports or ready-configured *Excel* files.

For example, the Scripting Module can be used to load previously generated samples and process them in sequence. In this case, a sample describes a possible configuration of deviations as they can occur in reality.

Figure 3 shows the sequence for the statistical tolerance analysis in this example. The calculation is configured in an XML file in which the components and the form and position

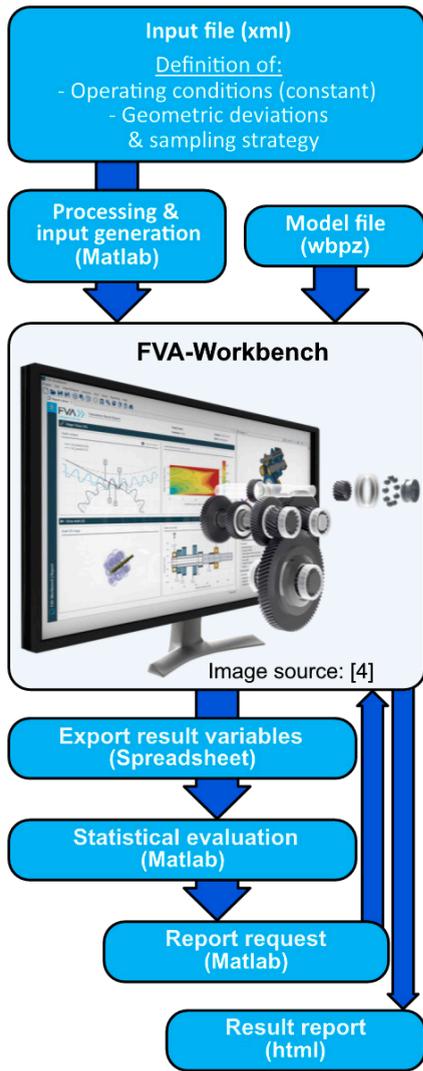


Figure 3—FVA-Workbench statistical tolerance analysis sequence for rolling bearing calculations.

deviations are defined. The samples are then automatically created based on the input file and the configured sampling strategy (randomly or systematically according to an experimental plan). The input file is processed by a MATLAB script, which saves the geometry data of the individual samples in an Excel file that can be read by the FVA-Workbench. A model file for which the calculations are to be performed is also required as an input.

The FVA-Workbench is then started in Batch Mode via a command line call and automatically processes the generated samples and saves the calculation results in an Excel file.

The statistical analysis of the results is then performed using suitable MATLAB scripts. A results report can also be generated for individual

Parameter	Value	Unit
Casing material	EN-GJL-200	-
Shaft material	16MnCr5	-
Shaft diameter d	90	mm
Rotational speed	2000	1/min
Radial force F	66.4	kN
Relative bearing load C/P	5	-
Bearing distance	356	mm
Bearing I type (LI)	NU216	-
Bearing II type (LII)	NUP216	-
Bearing clearance class	CN	-
Rolling element profile	DIN 26281	-
Outer ring temperature	70	°C
Inner ring temperature	75	°C
Rolling element temperature	77	°C
Lubricant	FVA3	-
Lubricant temperature	47	°C

Table 1—Constant calculation parameters.

samples in the FVA-Workbench. This report is output in HTML format and includes detailed, graphical calculation reports for the individual system components (e.g., shaft bending, flank pressure in tooth meshes, or lifetime).

Calculation Example

The following example will demonstrate the sequence using a simple system consisting of a casing and shaft with a fixed-floating bearing arrangement with a radial force F acting on the center of the shaft (see Figure 4).

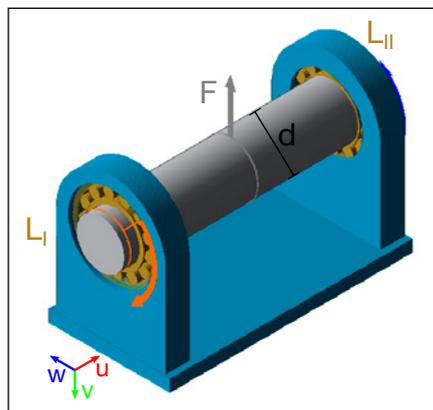


Figure 4—System model for the calculation.

Table 1 above provides an overview of the constant calculation parameters:

In addition to these constant parameters, a variable ovalization of the outer ring is also specified for Bearing I. The ovalization has an amplitude between 0 μm and 20 μm with a phase angle between 0 degrees and 360 degrees, modeled using a discrete Fourier transformation (DFT). Furthermore, a taper of the inner ring is also simulated with a value range of -5 to 5 angular minutes (').

The ovalization is represented in the FVA-Workbench as a form deviation of the outer ring in the circumferential direction (cf. Figure 1), whereas the taper is represented as an axial form deviation of the inner ring (cf. Figure 2). Furthermore, variation of the bearing clearance within the permissible limits of class CN is considered for both bearings. For bearing types NU216 and NUP216, this corresponds to an interval between 40 μm and 75 μm according to DIN 620-4 (Ref. 7). This is modeled as a change to the diameter of the outer ring, which is added to the ovalization.

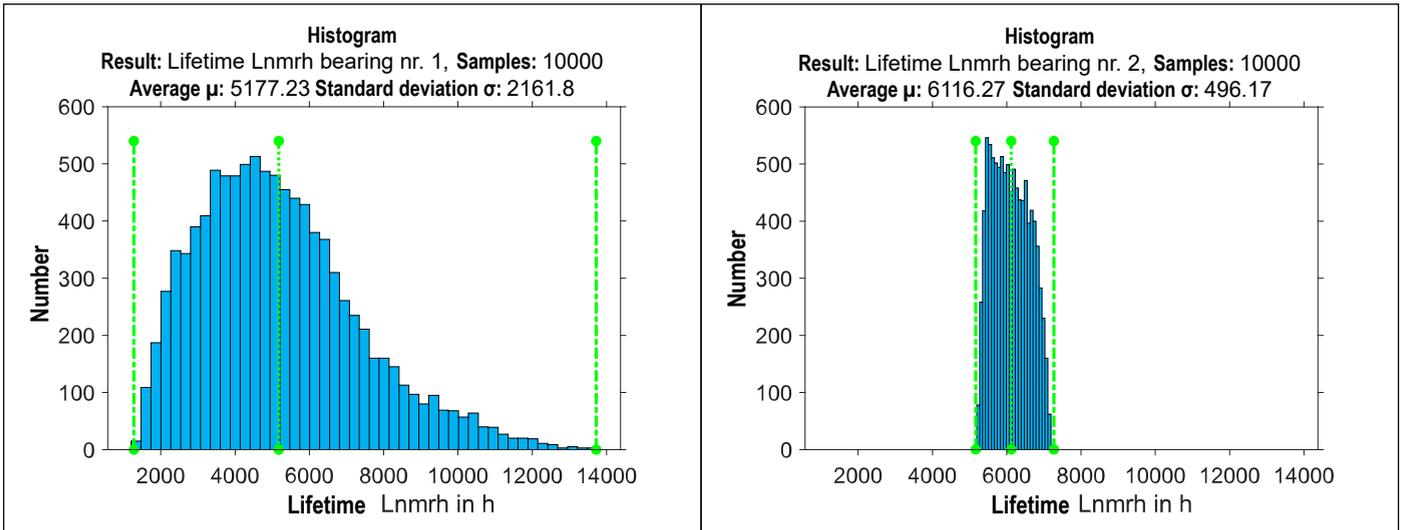


Figure 5—Lifetime L_{nmrh} histograms for Bearing I (left) and Bearing II (right).

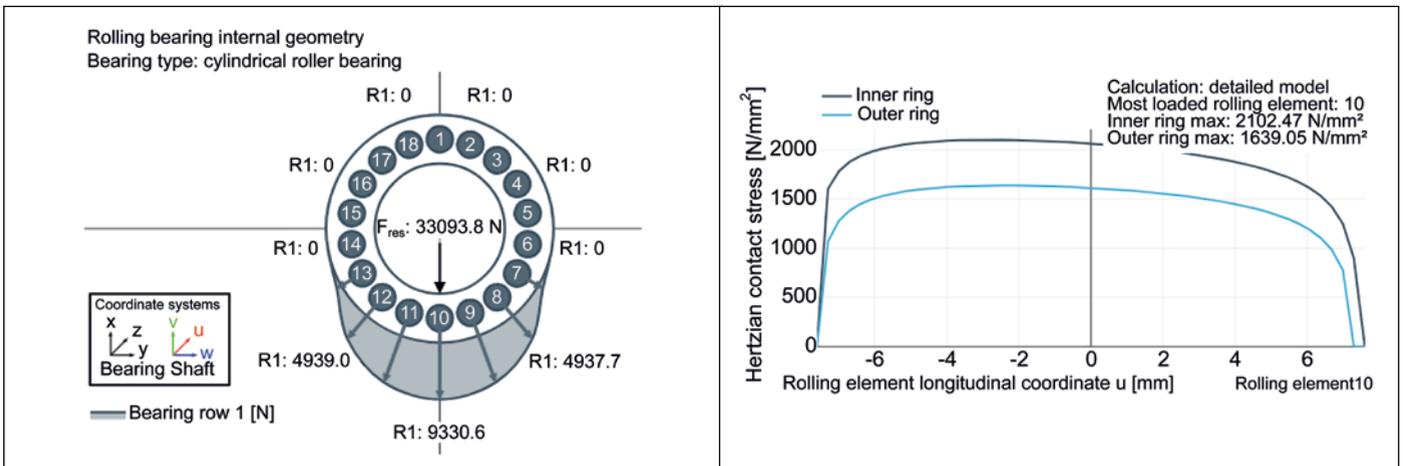


Figure 6—Rolling element load distribution (left) and axial pressure curve at the most heavily loaded rolling element (right) with median lifetime L_{nmrh} on Bearing II.

The concrete values for each individual sample are determined by Latin Hypercube Sampling.

A total of 10,000 individual cases are evaluated, with the sampling of the variable values following a Latin Hypercube Design (LHD) with minimized correlation of the variables. This sampling strategy achieves the best possible coverage of the space (Ref. 8). The calculation time is just under 90 minutes on a desktop workstation.

Figure 5 shows the distributions of the resultant modified reference lifetimes in hours (L_{nmrh}) according to DIN 26281 for both bearings in histogram form. It can be observed that the scatter is much greater for Bearing I than Bearing II. The value range for the lifetime of Bearing I extends

beyond that of Bearing II on both sides, meaning that both higher and lower lifetimes can occur than with Bearing II. This is due to the defined geometric deviations on Bearing I, the effects of which will be analyzed in more detail below.

For reference, the internal bearing load distribution on the rolling elements, as well as the axial pressure curves of the most highly loaded rolling element (number 10) for the inner and outer ring contact from the *FVA-Workbench* report, are shown in Figure 6 for the median value (6096 h) of the lifetime L_{nmrh} on Bearing II (where only the bearing clearance is varied within the limits of class CN). The deflection and the pressure distribution of the bearings are calculated

according to Teutsch & Sauer (Ref. 9). The rolling element load distribution (top) follows the typical arc-shaped curve, whereas the pressures in the axial direction (bottom) increase due to the shaft bending in the negative u -direction. It should be noted that greater Hertzian pressure occurs on the inner ring than on the outer ring due to the deforming contact.

By comparison, Figure 7 shows a visualization of the raceway geometries as well as the associated rolling element load distribution and axial pressure curves for the samples with minimum (left) and maximum (right) lifetime L_{nmrh} of Bearing I. As can be seen, there is clear ovalization of the outer ring raceway in both cases. For the sample with maximum

lifetime, the value is 18.06 μm . The large semi-axis is aligned parallel to the load. In this case, the inner ring raceway shows a taper with a negative pitch in the u-direction. The associated lead angle is -0.98 angular minutes.

Here, the lifetime L_{nmrh} of 13721 h is more than double the mean value of 6096 h for Bearing II, which is due to the positive influence of the geometric deviations on the internal bearing load conditions. In comparison to Bearing II, the ovalization leads to a more uniform load distribution on the rolling elements, and thus a significant reduction in the peak load (compare Figure 6 top and Figure 7 middle-right). While the maximum rolling element load is 9330.60 N for Bearing II, in the best case it is only 6350.70 N for Bearing I.

The taper on the inner ring compensates for the bending of the shaft. As a result, the axial pressure curve of the inner ring is almost symmetrical to the center line. The maximum Hertzian pressure sinks to 1776.0 MPa compared to 2102.47 MPa for Bearing II (compare Figure 6 bottom and Figure 7 bottom-right). This is also a result of the reduced rolling element load.

On the other hand, the geometric deviations have the opposite effect for the sample with the minimum lifetime. In this case, the bearing lifetime is greatly reduced to 1273 h compared to the mean value of 6096 h for Bearing II. Here, too, the outer ring is ovalized. The amplitude of 18.08 μm is almost the same as in the optimum case. However, the large semi-axis is transverse to the load direction (compare Figure 7 top left and right). This results in a more uneven load distribution on the rolling elements, and thus an additional increase to the peak load on the most highly loaded rolling element compared to Bearing II (11298.30 N, see Figure 7 center-left, compared to 9330.60 N, see Figure 6 top).

The lead angle of the taper is clearly positive ($4.94'$), which reinforces the axial stress gradient from the bending of the shaft. Instead of uniform load distribution in the circumferential and longitudinal directions as

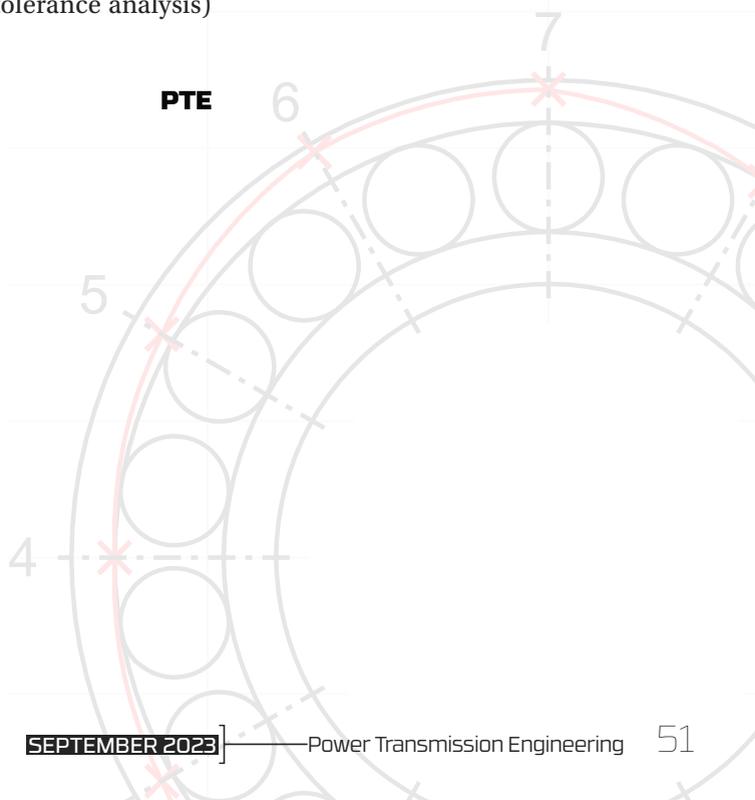
in the optimum case, the higher rolling element peak loads and the axial stress gradient lead to a pronounced maximum local stress at the edge of the most heavily loaded rolling element (maximum Hertzian pressure of 2626.07 MPa, compared to 1776 MPa in the optimum case or the Bearing II median lifetime of 2102.47 MPa, see Figure 6 bottom and Figure 7 bottom). As a result, the expected bearing life decreases significantly.

Conclusion

The example presented in this article clearly shows that geometric deviations of the bearing raceways have a significant influence on the key characteristics of rolling bearings, such as the lifetime considered here. In practice, this can be a result of deformation of the bearing rings during mounting due to bearing seat geometries that are not ideally cylindrical, for example. The effect depends on the bearing type and size as well as the operating conditions. However, this is not necessarily negative, and can even be clearly positive. The *FVA-Workbench* allows users to directly consider geometric deviations in bearing design. The integrated scripting interface also makes it possible to integrate user-defined calculation routines (e.g., ring deformations determined from FE calculations or statistical tolerance analysis) with little effort.

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All Paths Lead to...

FOREST CITY

Frederic (Fred) Marlin Young

(1943–2023)

Fred Young, 80, former president and CEO, Forest City Gear passed away on July 17, 2023. A graduate of Harlem High School, class of 1961, Young obtained his BA in English Literature from Rockford University, class of 1965, and went on to spend a year in the Navy Reserves. After spending nearly 40 years as an adventuring bachelor outdoorsman, he met the love of his life, Wendy Nutter, marrying her on the banks of the Wolf River on June 6, 1981. Fred's greatest joys were his three daughters, whom he taught to always seek adventure, bestow kindness and generosity, treasure friendship, and work hard and play hard. Fred took over the family business, Forest City Gear, in 1967. Founded by his parents in 1955, Fred took the small mom-and-pop shop to a global level, leading the company to manufacture some of the world's most difficult gearing for amazing end uses from NASA's Martian rovers and space station to robotic arms and racing yachts.

Young's full obituary can be found here:
geartechology.com/articles/30395-frederic-fred-marlin-young-19432023

Power Transmission Engineering asked members of the gear community to discuss Young's remarkable influence through the years:

"I met Fred 30 years ago when he welcomed me as an Australian gear manufacturer into his plant in Roscoe. Fred was very open in sharing the reasons for his success. Back then Forest City Gear were already a market leader and I could see why. His generous sharing of information led me to somewhat benchmark our business to his. Key point—his continual investment in the latest technologies. Having followed that lead, our company is now the market leader here in Australia. Always welcoming, Fred and I became good friends that extended to our personal lives. His introductions to other AGMA members helped me integrate into the organization and thus enhanced my gear industry experiences globally. Fred had an eternal presence. He will be sadly missed by the industry and all of us who were fortunate to have known him personally."

Gordon New, Ronson Gear

"It's really hard to just share a few words about Fred and his impact on the gear industry. Fred was the first person I met in the gear industry when I joined 15 years ago. Sam Haines, our CEO at the time, took me to meet Fred and to tour Forest City. Fred and the team at Forest City greeted me like they would as a member of their family. Over the next years I had the pleasure of working with Fred and Wendy in business and as part of the AGMA. During one of my visits to Forest City, Fred was hunting, but took time to talk to me while he was on vacation. I do not think most people realize the impact that Fred and Wendy have had on the AGMA. The AGMA we enjoy today is a product of their efforts to make it a welcoming and inclusive association. Their generation of leadership molded the AGMA into one that makes new members feel like family and allows for competitors to collaborate and share to make the entire industry better."

Dean Burrows, Gear Motions

"Fred Young and Forest City Gear became well known for and synonymous with high quality gear production utilizing modern CNC gear manufacturing machinery and CNC inspection and automation in the 70s and 80s when this equipment was first being introduced. He always had his door open to everyone and showcased his technology in an effort to advance gear production globally. He will be missed for his friendliness, good humor, and innovation in the gear industry."

David Goodfellow, retired, Star SU LLC

"Fred's legacy is incredible. Between his innovation and technical expertise to grow his company from a small shop to a global name who manufactures some of the most precise gears available, to the personal impact he had on everyone that knew him through his kindness and generosity, Fred was a true leader who will be dearly missed."

Matthew E. Croson, AGMA, president

September 13—Digital Factory 2023



Join dynamic keynotes and discussions from industry and policy leaders on Digital Design, Digital Manufacturing, Workforce Development, Sustainability and Supply Networks. Current speakers include the CEOs of Rockwell Automation, GE Digital, Formlabs, Autodesk, Re:Build Manufacturing and leaders from Hasbro, MIT, AWS, Steelcase, Atlas Copco, and the State of Massachusetts. Connect with like-minded organizations pushing the limits on digital transformation. Previous attendees include GE, Amazon, Ford J&J, PWC, MIT, Lockheed Martin, FedEx, John Deere and more. Experience a large space for technology discovery, including the full Formlabs product portfolio, fun networking meals and a hands-on pop-up factory where attendees can join the assembly line to make their own product. Digital Factory 2023 (Boston) is powered by Formlabs and Autodesk.

powertransmission.com/events/960-digital-factory-2023

September 26–28—Turbomachinery and Pump Symposia 2023



TPS (Houston) is a vital industry event, offering a forum for the exchange of ideas between rotating equipment engineers and technicians worldwide. Now surpassing 49 years, TPS is known for its impact on turbomachinery, pump, oil & gas, petrochemical, power, aerospace, chemical and water industries. The TPS technical program is hand-selected by advisory committees made up of key industry players and led by highly respected practitioners and leaders in their fields. Topics cover maintenance, reliability, troubleshooting, instruction on emerging designs, technology, and best practices that include case studies with real-world relevance on problems solved and lessons learned.

powertransmission.com/events/956-turbomachinery-and-pump-symposia-2023

October 17–19—Motion + Power Technology Expo 2023

Produced by AGMA, Motion + Power Technology Expo (Detroit) is a three-day show that connects professionals looking for motion power solutions with manufacturers, suppliers, and buyers. Attendees will find new power transmission parts, materials, and manufacturing processes. Buy, sell, and get business done with organizations in aerospace, automotive, agricultural, energy, construction and more. Hundreds of exhibitors and attendees means MPT Expo is a unique opportunity to find partners that can help fulfill your specific production needs. The show is collocated with Heat Treat 2023 and IMAT 2023.

powertransmission.com/events/948-motion-power-technology-expo-2023

November 12–15—2023 STLE TFC and E-Mobility Conferences



The 2023 STLE Tribology Frontiers Conference (TFC) will be held in Cleveland. The event will allow attendees to engage with world-renowned industry, academic and government researchers to learn more about the technical, environmental, and social issues impacting tribology research in the 21st Century. The 2023 STLE Tribology & Lubrication for E-Mobility Conference will be held in conjunction with the TFC from November 14–15. The event will feature educational sessions and networking discussions with leading industry experts covering technical content, analysis, and best practices.

powertransmission.com/events/944-2023-stle-tribology-frontiers-conference-and-tribology-and-lubrication-for-e-mobility-conference

November 14–16—SPS 2023

Numerous companies from all over the world have already registered for this year's automation highlight in autumn, SPS 2023 (Nuremberg). Among them are international key players such as Bosch Rexroth, SICK, Phoenix Contact, Beckhoff Automation, WAGO and Endress+Hauser, but also many small and medium-sized companies, start-ups and specialists who want to present their innovative automation solutions in Nuremberg. "After the successful restart last year, interest in the PLC has continued to grow and the feedback is already well above the previous year's level at the same time. In addition, we are currently in contact with many other companies, which makes us very positive and indicates that the SPS is developing again towards pre-corona levels," says Sylke Schulz-Metzner, vice president SPS at Mesago Messe Frankfurt. In order to meet the exhibitors' enquiries and wishes, organizer Mesago Messe Frankfurt is therefore planning to occupy two additional halls again.

powertransmission.com/events/949-sps-2023



BROWSE OUR BLOGS!

PTE features blogs to keep readers updated on the latest PT trends, technologies and industry solutions:

Bearings with Norm: After a several-years hiatus, we're pleased to welcome back our bearings blogger, Norm Parker.

Revolutions: Our editorial staff provides relevant and timely articles on a variety of PT industrial topics.

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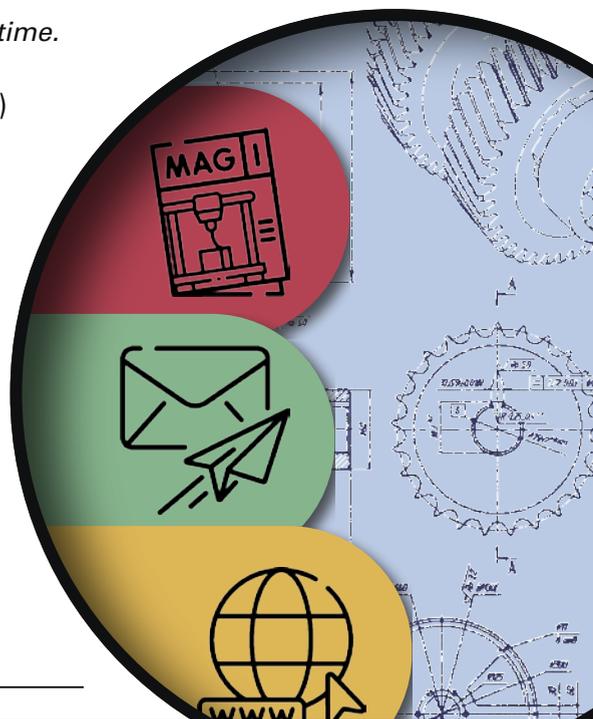
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A Second Chance on the High Seas

Transfluid's HM3350 Powers the *Western Flyer*

Matthew Jaster, Senior Editor

Author John Steinbeck chartered a 77 ft. fishing vessel known as the *Western Flyer* during his 1940 Gulf of California expedition. The voyage was chronicled in *The Log from the Sea of Cortez*, a book written by Steinbeck as he collected specimens with his marine biologist friend, Ed Ricketts. The *Western Flyer*—known as the most famous research vessel to have ever sailed—is getting recommissioned as a fishing showpiece for green technology.

“We were approached through our distributor Palmer Johnson to provide a competitive quote to the BAE system that was previously quoted. The customer liked that they could install only one diesel and use it as propulsion (parallel hybrid) as well, instead of using multiple gensets to power an electric motor (serial hybrid),” said Josh Welborn, OEM account manager at Transfluid LLC.

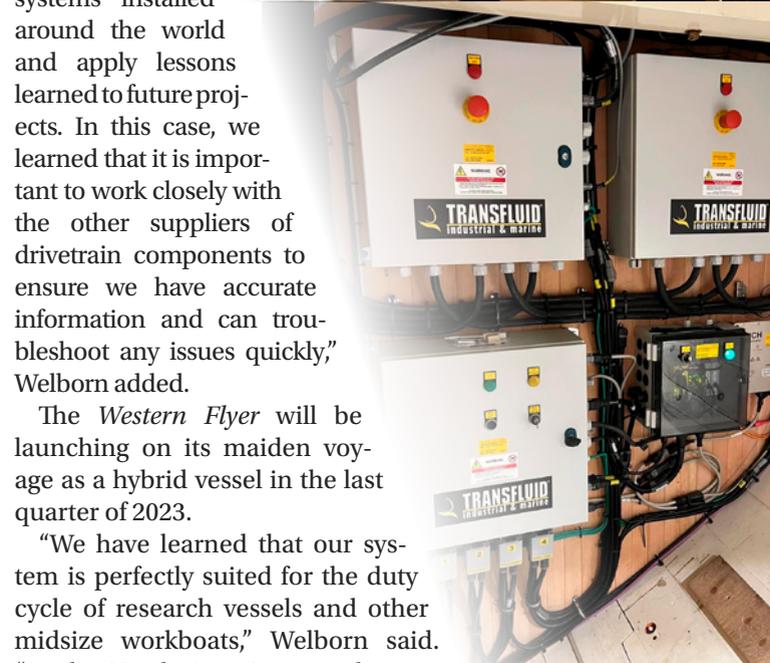
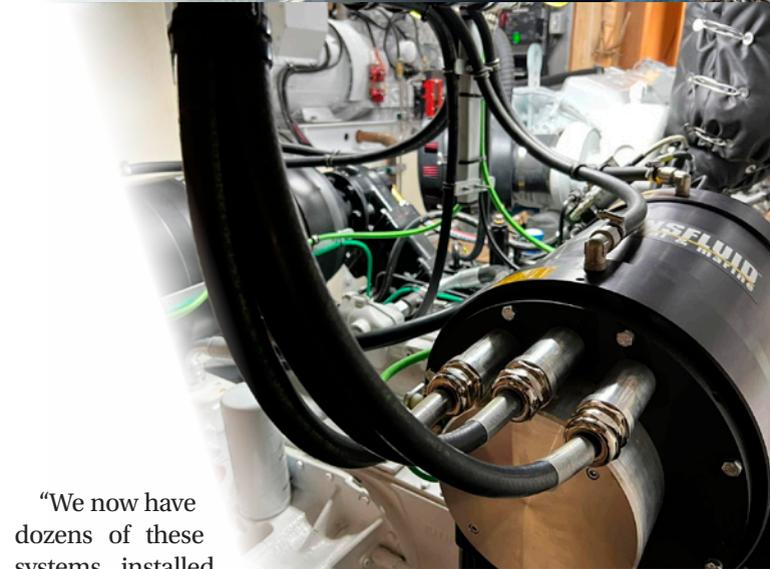
The *Flyer* is powered by a 425 hp John Deere diesel onto which is mounted the HM3350 hybrid module. For the electric propulsion, twin 100 hp electric machines will allow the *Flyer* to reach hull speed in electric mode and perform standby operations silently. This is extremely valuable when collecting data onsite.

The HM3350 features three additional PTO heads which will drive the steering pump as well as a clutchable pump to operate the research equipment. Head extensions for the PTO heads allow for a seamless integration with the Tier 4 diesel and marine gear.

Transfluid has provided the propulsion control, CANBUS communication system, and all components to make the complete hybrid supply. The operator can switch on the fly from diesel to electric mode with the press of a button and engage or disengage the hydraulics from the control bridge.

“We required 27” of space between the flywheel of the engine and the input of the marine gear. This was accomplished by shortening the propeller shaft and moving the engine forward. As part of our supplied package, we performed a TVA on all components connected to our drive and required information from the engine manufacturer and marine gear manufacturer, as well as the hydraulic pump supplier since we used the free PTO heads on our drive to power their hydraulics,” Welborn said.

For energy storage, 115 kWh of lithium iron phosphate batteries provide autonomy in electric mode and power the house systems. The boat can charge while underway in diesel mode using the power of the engine, or while docked using shore power.



“We now have dozens of these systems installed around the world and apply lessons learned to future projects. In this case, we learned that it is important to work closely with the other suppliers of drivetrain components to ensure we have accurate information and can troubleshoot any issues quickly,” Welborn added.

The *Western Flyer* will be launching on its maiden voyage as a hybrid vessel in the last quarter of 2023.

“We have learned that our system is perfectly suited for the duty cycle of research vessels and other midsize workboats,” Welborn said. “As the North American market continues to embrace hybrid technology, we will find many more similar projects to provide a fully engineered solution at a competitive price.”

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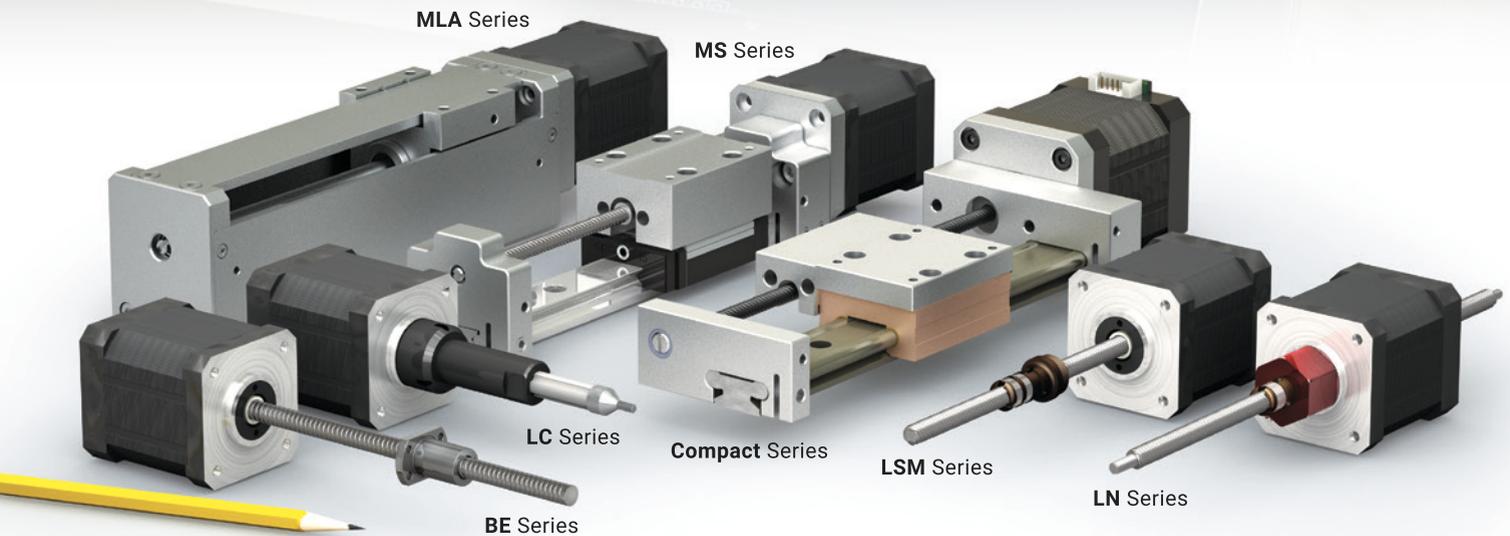
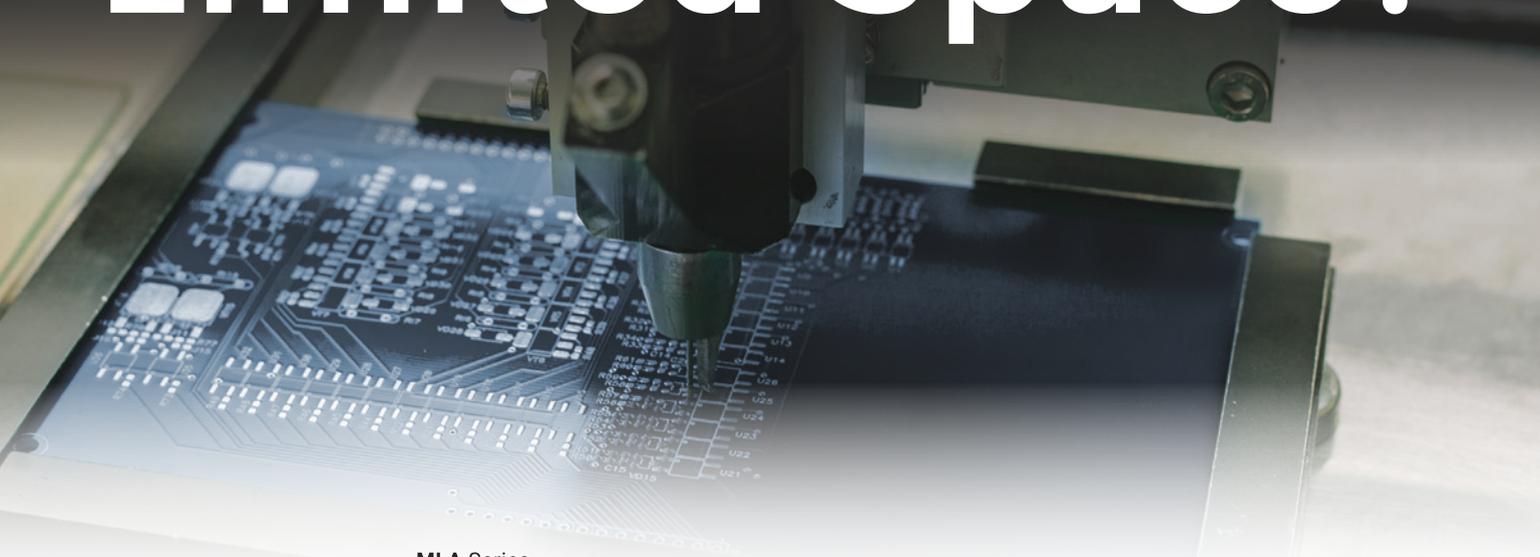
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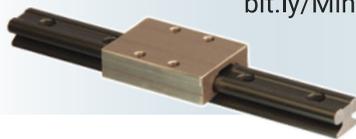
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