PTE

POWER TRANSMISSION ENGINEERING™

APRIL
2025

HUMANOID COMPONENT ADVANCEMENTS

LINEAR AXIS SYSTEMS

AUTOMATE 2025

AUTONOMOUS INSPECTION

TECHNICAL

Advanced Lubricant Technology for Open Gear Applications

powertransmission.com

Multi-Axis Servo Systems with EtherCAT®

These iX7 systems offer EtherCAT or ModbusTCP control at a fantastic price!

Complete Servo Systems starting at: **$964.00** (100W)

LS ELECTRIC

EtherCAT®

LS Electric® iX7 Servo Systems

Starting at $964.00 (100W system with cables and I/O breakout)

LS Electric iX7 servo systems offer advanced multi-axis motion control along with EtherCAT networking. The EtherCAT protocol provides extremely fast, real-time, deterministic, and synchronized communication for high precision motion.

- 9 standard servo systems from 100W to 3.5kW
- Multiple input power options:
  - 110VAC single-phase up to 400W
  - 230VAC single-phase up to 2.2k
  - 230VAC three-phase in all sizes
- Use with any CANopen over EtherCAT (CoE) compatible PLC/host controller or one with ModbusTCP capability
- Fully digital with 1kHz velocity loop response
- Matched gearboxes available for all systems in 5:1. 10:1, and 20:1 ratios
- 45-day money-back guarantee
- One-year warranty

EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

Use our LS Electric Servo System Selector Tool to size your system, and to specify all the required and optional accessories for YOUR application. Get ALL the parts you need on the first order!

Online LS Electric Servo System Selector Tool
www.automationdirect.com/selectors/ls-servo

Need an EtherCAT controller?

LS Electric® XGB PLC

CPUs starting at $279.00 (w/FREE software)

The LS Electric XGB PLC controls up to 16 axes of EtherCAT® motion with several positioning methods including linear, circular, helical, and ellipse interpolation. Seven homing routines are also available and the FREE software offers a graphical interface so you can see the motion in action! The XGB series PLC is a perfect control solution for:

- Palletizers
- Pick-and-place applications
- Rotary tables
- Flying cutoff systems
- Precision machining tools
- Automated welding systems
- and much more

LS XGB PLC

PLC systems with a 4-axis EtherCAT positioning module starting at $629.00 *(not including servo systems)*

Research, price, buy at: ***www.automationdirect.com/servos***

Order Today, Ships Fast!

TOP RATED BY CUSTOMERS

AUTOMATIONDIRECT.com

1-800-633-0405 the #1 value in automation

PTE™

APRIL 2025

FEATURE ARTICLES

STAY CONNECTED

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

Subscribe Online
powertransmission.com/subscribe

TECHNICAL ARTICLES

Vol. 19, No. 3. POWER TRANSMISSION ENGINEERING (ISSN 2331-2483) is published monthly except in January, May, July and November by The American Gear Manufacturers Association, 1001 N. Fairfax Street, Suite 500, Alexandria, VA 22314, (847) 437-6604.

Periodicals Postage Paid at Elk Grove Village IL and at additional mailing offices.

PTE™

VOL. 19, NO. 3

COMPONENTS, ENGINEERING DEVELOPMENT, AND MANUFACTURING

SDP/SI
STOCK DRIVE PRODUCTS/STERLING INSTRUMENT

Precision Gears and Superior Mechanical Components

We know what it takes! Consistent Quality, Dependability, & Experience

Our Certifications
ISO 9001 + AS9100
ITAR Compliant-DDTC Registered
DFARS Compliant
RoHS & R.E.A.C.H. Compliant
NIST SP 800-171 Compliant

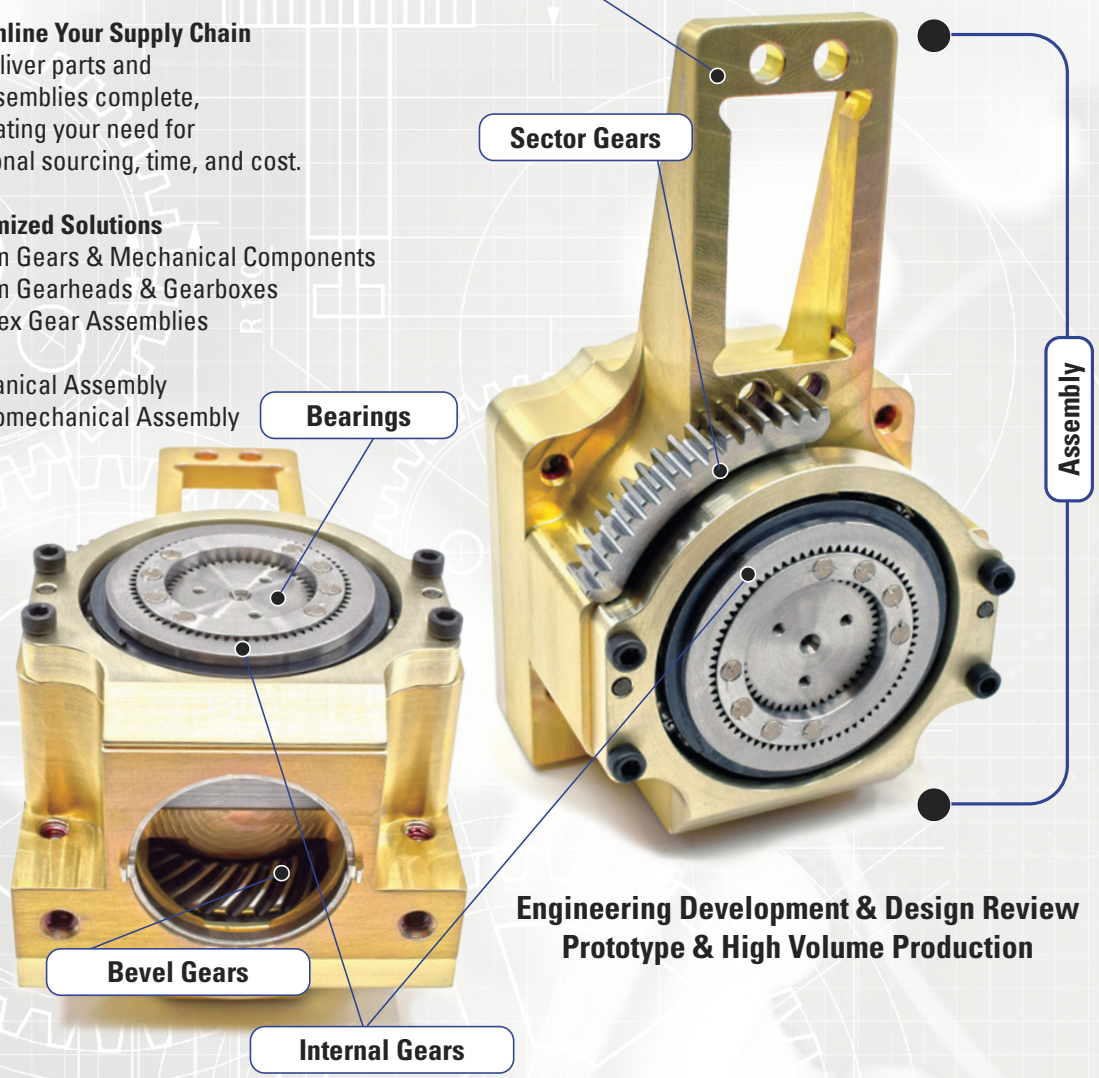
See us at Robotics Summit
Boston, MA. April. 30th - May 1st, 2025
Booth# 634

Turning Ideas into Reality since 1950
Engineering development, design, and manufacturing expertise combined with mechanical and electromechanical component options.

Streamline Your Supply Chain
We deliver parts and subassemblies complete, eliminating your need for additional sourcing, time, and cost.

Customized Solutions
Custom Gears & Mechanical Components
Custom Gearheads & Gearboxes
Complex Gear Assemblies

Mechanical Assembly
Electromechanical Assembly



Engineering Development & Design Review
Prototype & High Volume Production

AGMA

Designatronics INC.
Engineered Solutions for a World in Motion

SDP/SI STOCK DRIVE PRODUCTS/STERLING INSTRUMENT · QBC QUALITY BEARINGS & COMPONENTS · QTC METRIC GEARS

Web: sdp-si.com • **Email:** sdp-sisupport@sdp-si.com • **Phone:** +1 516.328.3300

PTE EXTRAS

Beyond Motors: Gearboxes as the unsung heroes in robotics and heavy-duty machines

Modern robots and machines are no longer just tools; they are becoming intelligent, efficient, and adaptive systems that redefine how we interact with machines in our daily lives. This shift is not only changing industries from manufacturing to construction but is also paving the way for smarter, more sustainable, and useful mechanical solutions.

powertransmission.com/beyond-motors-gearboxes-as-the-unsung-heroes-in-robotics-and-heavy-duty-machines

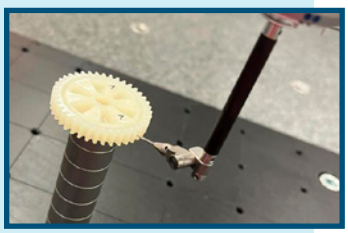
The Reliability Game: Atlantic Bearing Services focuses on experience, ingenuity and investment

Call it destiny, divine intervention or good ole-fashioned fate, speaking with Alejandro Pardiñas, CEO of Atlantic Bearing Services (ABS) and ABS Wind, one gets the impression he had no choice other than to become a mechanical engineer. This was evident way back when his great-grandfather became a mining engineer for Rio Tinto.

powertransmission.com/the-reliability-game

AS SEEN IN *GEAR TECHNOLOGY*

An Experimental Study on the NVH Performance of Plastic Gears



High-performance plastic gears are increasingly replacing metal gears in a multitude of applications due to their many advantages. The most important of these are lower weight, substantially reduced lubrication requirements, more cost-effective mass production, significantly better NVH (noise, vibration and harshness) behavior, and chemical resistance.

geartechnology.com/an-experimental-study-on-the-nvh-performance-of-plastic-gears

powertransmission.com

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

EDITORIAL
Publisher & Editor-in-Chief
Randy Stott
stott@agma.org

Senior Editor
Matthew Jaster
jaster@agma.org

Senior Editor
Aaron Fagan
fagan@agma.org

GRAPHIC DESIGN
Design Manager
Jess Oglesby
oglesby@agma.org

ADVERTISING
Advertising Sales Manager & Associate Publisher
Dave Friedman
friedman@agma.org

Manager, Member Engagment and Sales
Katie Mulqueen
mulqueen@agma.org

Materials Coordinator
Dorothy Fiandaca
fiandaca@agma.org

CIRCULATION
Circulation Manager
Carol Tratar
tratar@agma.org

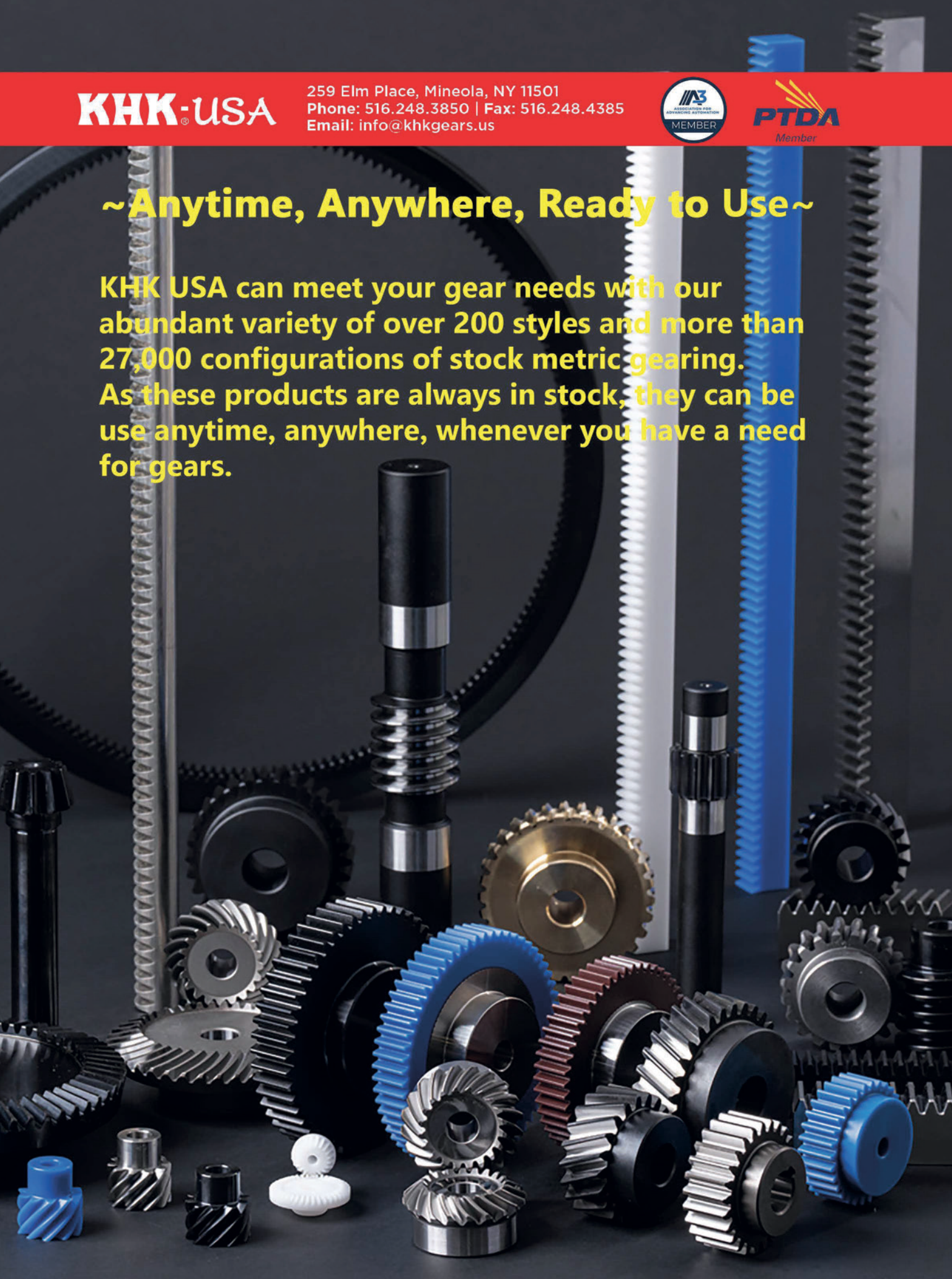
MANAGEMENT
President
Matthew Croson
croson@agma.org

FOUNDER
Michael Goldstein founded *Gear Technology* in 1984 and *Power Transmission Engineering* in 2007, and he served as Publisher and Editor-in-Chief from 1984 through 2019. Michael continues working with both magazines in a consulting role and can be reached via e-mail at *mwg42@hotmail.com.*

KHK-USA
259 Elm Place, Mineola, NY 11501
Phone: 516.248.3850 | Fax: 516.248.4385
Email: info@khkgears.us

~Anytime, Anywhere, Ready to Use~

KHK USA can meet your gear needs with our abundant variety of over 200 styles and more than 27,000 configurations of stock metric gearing. As these products are always in stock, they can be use anytime, anywhere, whenever you have a need for gears.



Who Can You Trust?

We've made a lot of changes at *PTE* lately, including the redesign of our printed magazine and website with a sleek new logo and a more comfortable, vibrant, readable look and feel. You might think these changes are largely cosmetic. But they're not. We began the process more than a year ago, and from the beginning, every decision was driven by a desire to serve you, the reader.

Our goal? To build and grow trust.

Over the past decade, media companies have gone too far in the effort to capitalize on the public's willingness to endlessly scroll through mindless content. Clickbait has become more important than fact, and the line between the bottom line and editorial integrity has become blurred (or even erased).

Here at AGMA Media, we're doubling down on integrity. You might notice in our new designs that advertising is clearly marked or delineated. That's definitely on purpose. Both online and in print, ads and sponsored content are separated from editorial by a light grey background. On the website, advertising is labeled as advertising, and sponsored content (such as white papers or webinars) is labeled as sponsored.

What's the difference, you ask?

Editorial items are chosen and prepared by our editorial team. They edit out superfluous, ambiguous and biased content. They try to make sure that facts are represented as facts, and opinions represented as opinions. Their job is to deliver the information that will be most useful to you. In this way, the editors act as your filter.

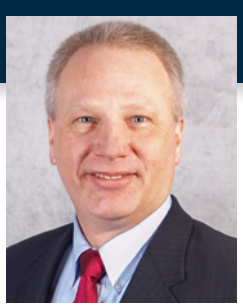
In fact, from that perspective, the editors don't really work for me, or even AGMA. They work for you.

Advertising and sponsored content, on the other hand, are prepared by the suppliers in our industry and delivered to you as-is—and that's a wonderful thing. The information presented in advertisements and sponsored content is among the most valuable information we offer, because the companies who produce it are the most knowledgeable about the technologies, products and processes involved. We've heard time after time from our readers how much they value that content, and we couldn't provide the full picture without it.

I hope you'll take a few moments to visit the new website at *www.powertransmission.com* to better understand some of the changes we've made and the depth of our commitment to you. I'm confident you'll like what you see enough to renew your subscription at *www.powertransmission.com/subscribe/*

PTE

P.S. Since we work for you, then technically you're our boss, and it's time for you to give us our annual performance review. In addition to renewing your subscription, we'd love to get some feedback—positive or negative—about how we're doing. Send your comments about the redesign, your faith in B2B media or any piece of content you see. E-mail me directly at *stott@agma.org*.



Randy Stott

Randy Stott
Publisher & Editor-in-Chief

cti symposium US

AUTOMOTIVE · PROPULSION · SYSTEMS

13/14 MAY
NOVI

DRIVE THE FUTURE –
POWERING INNOVATION, CONNECTING INTELLIGENCE

Micky Bly	**Jordan Choby**	**Emad Dlala**	**Elizabeth Krear**	**Dr Nader Nasr**
Stellantis	Toyota	Lucid Motors	JD Power	Oshkosh Corporation

400 + Industry Representatives	**10** Deep Dive Sessions	**70 +** Expert Lectures	**25 h +** Content & Networking	**40 +** Exhibitors	**New** Start-Up Area

Register now
cti-symposium.world/us

BECKHOFF AUTOMATION

Retrofits Conveyor Technology Control System

For every online retailer, warehouse logistics is part of the critical infrastructure: If the conveyor lines come to a standstill, it generally won't be possible for any more packages to get out. To prevent this, an Australian office equipment supplier has retrofitted the warehouse logistics installation of its central warehouse. In its role as project manager, Layer Seven Automation replaced the proprietary decentralized controllers of the conveyor lines with PC-based control from Beckhoff, based on powerful EtherCAT communication.

The end user is one of Australia's leading office equipment suppliers, with a broad portfolio ranging from office supplies and computers to office furniture. The company operates more than 100 stores across Australia as well as an online store with more than 40,000 products. At main distribution center, the stored goods are removed from shelves and packed into boxes, then transported along various conveyor lines—with a total length of 700 m and 28 distribution stations—and prepared for dispatch.

The conveyor lines had operated reliably for many years, but it had become apparent that the systems were reaching the end of their service life. Malfunctions were occurring more and more frequently, and the required spare parts had become increasingly difficult to obtain and more expensive due to the age of the system. As a result, the management of the office equipment supplier commissioned Layer Seven Automation from Bella Vista (in the Sydney metropolitan area), which specializes in warehousing and logistics projects, to develop a concept that would modernize the warehousing system.

The evaluation revealed that the mechanics of the main conveyor belt were still in a usable state, but that the control system needed to be replaced. Lucky Thommadura, cofounder and chief engineer at Layer Seven Automation, said: "One of the disadvantages of the conveyor system was its proprietary structure. Every part had to be purchased from the manufacturer, which would have made it even more difficult to expand the system." As a result, the decision was made to configure an open system based on off-the-shelf products. "This would offer a future-proof solution and reduce maintenance costs."

The original system configuration was based on one controller and one barcode scanner for each distribution station. Layer Seven Automation's aim was to create a centralized control architecture that would increase the efficiency of the system and reduce costs.

The barcode scanners at each station are essential for recording the contents of the boxes. Here, Layer Seven Automation opted for scanners that can be configured via an EtherCAT interface and have integrated I/Os for simple control functions. The inputs are used to detect the boxes via opto sensors, for example, while the outputs are used to switch the switches or pushers according to the destination station.

First, a single distribution station was converted, and its scanner was connected to a C6920 control cabinet Industrial PC from Beckhoff via EtherCAT. Following successful tests, all 28 stations were migrated in stages and networked with the C6920 in a linear structure (daisy chain).

"The technicians of the logistics company and I were surprised by the compactness of the solution, the fast update rates of the EtherCAT network, and the overall speed of the controller," said Thommadura.

After all, the barcode on the box must be scanned and forwarded to the industrial PC via EtherCAT. There, the application determines whether the switch of the corresponding station needs to be switched and sends this information back to the barcode scanner via EtherCAT. "The Beckhoff Industrial PC manages the extensive calculations in around 100 µs, which is phenomenally fast," said Thommadura enthusiastically, "and yet we still have reserves."

Even though there has not yet been a network failure, carelessness can quickly cause a cable break and thus a failure of the entire system. A shutdown of this kind would have a significant impact on productivity, especially on such a large-scale logistics installation. There are therefore concrete plans to implement cable redundancy, which is easy to retrofit with EtherCAT.

beckhoff.com

ABB
Expands HVACR Motor Product Line

ABB has expanded its HVACR motor product line with the launch of ERH, a highly efficient, compact and lightweight solution for fan wall applications. This advanced motor technology delivers plug-and-play, variable-speed operation for simplified installation and lower energy consumption.

"Facility managers and OEMs face increasing pressure to cut operation costs, improve system performance and meet sustainability goals," said Bevan Christiansen, ABB global segment manager for air handling. "The ERH motor is our solution—a direct-drive motor that removes unnecessary components, minimizes energy waste and optimizes airflow efficiency."

Traditional fan systems often require complex installation and frequent service and cause excessive energy use. ABB engineered ERH to address these challenges by eliminating belts, couplings and other components from the system, reducing mechanical stress while extending operational life. With IES5 efficiency, ERH cuts power costs while improving airflow control.

ERH's variable-speed control allows precise adjustments, ensuring optimal ventilation while preventing wasted energy. The motor consumes as much as 40 percent less electricity than standard induction models run across the line, which leads to substantial cost savings over its lifespan.

Unlike conventional units that demand extensive programming and commissioning, ERH arrives pre-configured for immediate use, making setup quick and hassle-free. Its compact and lightweight build allows for easier integration into HVACR systems.

With an IP65-rated enclosure, ERH withstands demanding environments while maintaining efficiency and durability. Its exterior rotor flange mount provides a torque-dense, space-saving design. Built for long-term durability, ERH features sealed, greased-for-life bearings to reduce maintenance demands. Enhanced electrical discharge machining (EDM) protection prevents damage, while ultra-quiet operation makes it ideal for noise-sensitive environments.

Designed and assembled in the United States, ERH supports a variety of air-handling applications, including data centers, hospitals and commercial and industrial buildings.

ABB's global service network provides ongoing support, offering OEMs and facility operators a future-ready solution that meets evolving industry standards.

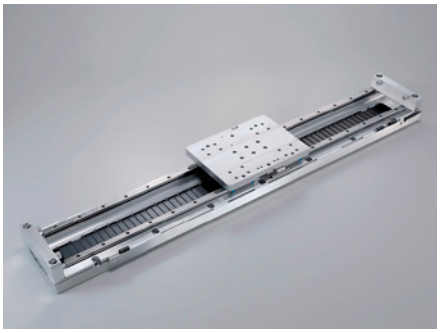
abb.com

IKO
Offers High-Thrust Linear Motor Stage

IKO is pleased to announce its LT170H2 direct drive linear motor stage for dynamic applications such as semiconductor fabrication which require high thrust forces and long strokes.

This latest addition to the LT family of linear motor stages delivers 260N of rated force and up to 500 N maximum, exceeding the thrust ratings of previous LT stages and expanding the linear stage series' range of suitable applications—especially those that involve positioning heavy objects in tight spaces.

Its redesigned linear motor leverages direct drive technology that is free of mechanical power transmission parts that can otherwise hinder positioning accuracy.



The LT170H2 also comes with C-Lube linear bearings for guidance. Together, they allow the positioning stage to achieve higher thrust forces and high speeds with exceptional precision. Additional features and specifications include:

- High speeds up to 3,000 mm per second.
- Repeatable speeds thanks to its low-cogging motor design.
- Reduced cycle times versus the previous LT...H positioning table.
- Long strokes up to 2,750 mm.
- Compact size and a 170 mm width.
- Low power consumption due to the high thrust rating. In fact, the LT170H2 consumes approximately 48 percent less power than the previous LT...H unit.

In addition to semiconductor fabrication applications, the LT170H2 is also well-suited for use in measuring instruments, assembly systems and material handling machinery.

ikont.com

KUKA
Adds KR IONTEC Ultra to Robotic Portfolio

The new KR Iontec ultra completes KUKA's portfolio in the payload

range of 80 to 120 kg. With a reach of 2,300 to 2,700 mm, this compact and powerful robot offers maximum efficiency and flexibility in the modern production environment—for example in handling or spot welding with lightweight welding guns.

Thanks to its compact design, the KR Iontec ultra can easily find its way into even the tightest of spaces: customers can use the slim robot to create narrow automation cells. As a result, the space saved leads to lower costs. In addition to the small footprint, the robot has very good performance, which helps to minimize cycle times.

The KR Iontec ultra fits seamlessly into the KR Iontec family, which has impressively low maintenance requirements: an oil change is only necessary every 20,000 operating hours and the central hand concept does not require belts. The robot has a streamlined build with fewer breakable small parts.

The all-rounder demonstrates its strengths in handling—especially in the battery area—and in spot welding with lightweight welding guns (lightweight spot welding). With its payload of up to 120 kg, the robot can move heavy battery cells and modules for use in electromobility. The slim robot also fits perfectly into compact welding cells—a feature that is highly sought after by suppliers to the automotive industry, for example.

In the KUKA portfolio, the KR Iontec ultra has the advantages of both the KR Iontec and KR Quantec product families. With a smaller footprint than the KR Quantec and high performance at the same time, it is a cost-effective option for entry-level automation. "The KR IONTEC ultra can be quickly and intuitively integrated into existing production environments," says Michael Laub, platform product manager medium payload and palletizing robots at KUKA.

As the robot can be implemented with the KUKA.PLC mxAutomation interface, it can be programmed and operated by the user in a familiar control environment. This means that the compact, powerful and cost-efficient robot can quickly make its contribution to production in various handling applications and in spot welding with lightweight welding guns. The KR IONTEC ultra with a payload capacity of 120 kg and a reach of 2,700 mm is available to order now, with three further model variants to follow this summer.

kuka.com

APPLIED MOTION PRODUCTS

Introduces AW Stepper Motors

Applied Motion Products introduces the AW Stepper Motors, featuring an IP65-rated design that ensures reliable operation in harsh environments. Engineered for a high level of protection, these motors effectively shield internal components from external contaminants such as dust, dirt, moisture, and grease.

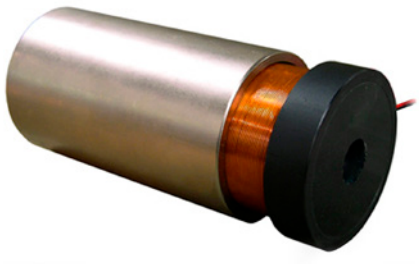
AW Stepper Motors are extensively utilized in the medical, mining, steel, petrochemical, and food processing industries. They ensure continuous and reliable operation in high temperatures, high humidity, dusty conditions, and moderately corrosive environments. Known for their reliability and long service life, these IP 65-rated motors help minimize maintenance and downtime, enhance production efficiency, and ensure dependable machine performance.

applied-motion.com

MOTICONT

Releases Miniature Linear Servomotors

The LVCM-013-019-02 (Imperial version) and the LVCM-013-019-02M (Metric version) linear motors released by Moticont feature high acceleration/deceleration, and low inertia. Two brushless high speed linear servomotors with a 0.75 in (19.1 mm) long stroke, have a high force-to-size ratio of 2.9 oz (0.81 N) and a peak force of 9.0 oz (2.51 N) at a 10 percent duty cycle. Operated in a closed loop as a DC servomotor, these miniature linear servomotors have high accuracy and high repeatability, and are clean, quiet, reliable, and efficient.



These linear voice coil servomotors are also known as moving coil motors or linear actuators, is 1.156 in (30.2 mm) long at midstroke. These high force-to-size linear servomotors are ideal for: Scanners, laser beam steering and filtering, haptic feedback, dynamic vibration absorption, dispensing, work holding and clamping, assembly, testing, and wafer handling.

The LVCM-013-019-02 has 4-40 UNC-2B threaded holes in the center of the housing and the coil end, and the LVCM-013-019-02M has M3X0.5 threaded mounting holes for easy integration of these linear servomotors into new or existing applications. Single or multiaxis plug-and-play servo controllers and linear encoders are available for all Moticont linear motors.

moticont.com/voice-coil-motor.htm

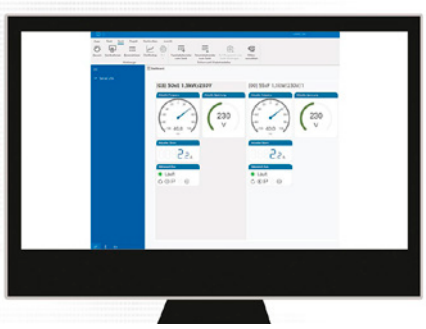
NORD

Releases New Enhanced Technology for Control of Electronic Drives

The updated *Nordcon* 3.0 software tool for Windows and mobile devices delivers a more streamlined design for efficient drive control, parameterization, programming, and analysis.

The *Nordcon* software tool from Nord Drivesystems enables easy access to electronic drive systems, simple parameter management, drive programming, and comprehensive diagnosis. The software is

available as a Windows app as well as a mobile app for iOS and Android, allowing the full performance of Nord technology to be implemented across multiple devices with a uniform user interface. *Nordcon* is applicable for all Nord variable frequency drives, motor starters, and bus modules, and is capable of handling all tasks from application development, commissioning, operation and service.



Commissioning of an electronic drive system requires the setting of various parameters. With *Nordcon*, numerous drives can be addressed simultaneously via the integrated interface—regardless of whether it is a single-axis or multiaxis solution. The connection to the frequency drive is by default preconfigured via serial interface however connection via Ethernet can also be established. The software's project mode additionally supports application engineers when commissioning a larger number of electronic drive systems via an Industrial Ethernet network.

Nord recently announced an update to the software tool with *Nordcon* 3.0 for the Windows app. This update features many design improvements including implementation of a modern interface design with a ribbon style navigation toolbar, allowing easy access to commands and functions with clear grouping of tabs subdivided by categories. Like the mobile app, the Windows parameter screen now offers a clearer display with a context-sensitive help function that integrates all relevant parameter information from Nord's technical documentation. A new index and search function also makes it easy to find any parameter quickly.

Drive monitoring with help from the *Nordcon* dashboard provides an optimal visualization of all application-relevant drive information in one convenient location. It can be easily customized with different tile types to showcase important parameters of the drive system for quick monitoring and fault diagnosis. The multiwindow dashboard also supports fast import/export of application specific dashboard settings between colleagues as well as the *Nordcon* mobile app.

nord.com

SENSOR TECHNOLOGY

Assists RTEC Engineering with Dynamometer Technology

RTEC Engineering Ltd. is on a mission to redefine accuracy standards for dynamometers amid the growing global interest in enhancing engine efficiency and performance.

Rob Langton, the managing director of RTEC Engineering Ltd and an engineering metrologist with over two decades of experience, sheds light on their innovative approach: "Our sub-division, RTEC Powertrain, is actively engaged in collaborative projects with B2B partners, concentrating on metrology solutions for the automotive industry, including ECM (engine control module) calibration and diagnostics."

Facing the challenge of obtaining a detailed performance profile for a specific engine within a constrained capital budget, Langton took matters into his own hands. Drawing on his extensive engineering expertise, he embarked on designing and manufacturing a dynamometer that replicates the accuracy and reliability of OEM or lab-grade systems but at a more accessible cost for small to medium-sized enterprises.

Striving to surpass the limitations of load cells and rpm sensors commonly found in traditional dynamometers, Langton turned to advanced technology. After researching specialized literature, he discovered Sensor Technology in Banbury and their noncontact TorqSense transducer.

Engineers from Sensor Technology assessed Langton's requirements and recommended the SGR510/520 series TorqSense. This transducer employs a full four-element strain gauge bridge. A rotor-mounted ultra-miniature microcontroller, powered by a noncontact inductive coil, measures strain values and transmits them digitally to the stator, providing high-precision torque measurements.

Langton highlights the benefits: "The inductive coils eliminate the need for wires with slip ring connections to the shaft, offering the ease of use we desire." He underscores TorqSense's remarkable overrange capacity, enabling accurate measurement of sudden load spikes. Additionally, its immunity to noise and signal corruption, common in slip ring setups, along with a 4,000/sec sampling rate, aligns seamlessly with their resolution requirements.

With Sensor Technology's assistance, RTEC swiftly developed an ideal solution for manufacturing a high-performance dynamometer aligned with their design specifications. Recognizing the potential broader applications, Langton explored the market's needs, leading to a realization of a gap that RTEC aims to fill.

sensors.co.uk

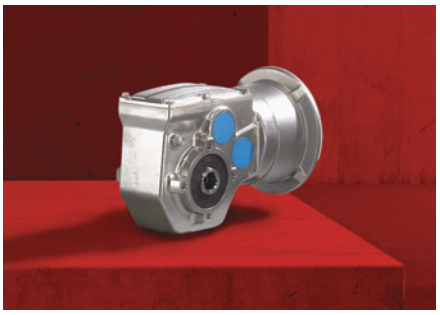
KISSSOFT
Presents Load Spectrum Calculation

The *KISSsoft System Module* is a user-friendly tool also for load spectrum calculation designed for gearboxes. It incorporates nominal boundary conditions, variable forces on shafts, gear shifts, and hence changes in the power flow and operating mode variations. This complexity allows comprehensive calculations based on actual operating data, such as vehicle simulations or in situ measurements. This is particularly valuable for hybrid drive transmissions, continuously variable transmissions, and considering driving vs. coasting operation. For all bins in the load spectrum, the power losses are calculated, informing about the transmission efficiency. Each load case in the spectrum also serves as a nominal load for a single load calculation. Detailed reports for gears, bearings, and shafts clearly present key data, while the software supports easy export of load data for in-depth component analysis. Its intuitive interface ensures fast, accurate, and reliable calculations while saving engineer's time.

kisssoft.com

SEW–EURODRIVE
Introduces WES Series Stainless Steel Drives

SEW-Eurodrive is proud to introduce the WES Series stainless steel gear unit, a compact, hygienic drive solution that runs cool—even under continuous operation. Unlike worm gear units that overheat, the WES Series integrates SPIROPLAN right-angle gearing, ensuring smooth, reliable performance without excessive heat buildup. Designed for food, beverage, and other hygienic applications, the WES Series is corrosion-resistant, easy to clean, and rated for high-pressure washdowns.



Key Advantages include:

Compact & Efficient: No cooling fan, no hygiene risk—ideal for clean environments.

Always Runs Cool—Safe & Reliable: SPIROPLAN gearing minimizes friction, reducing heat compared to worm gear units. No burn hazards, ensuring worker and product safety.

Hygienic & Washdown-Ready: Rated for aggressive cleaning agents and washdown environments. Seamless, smooth surface prevents bacteria buildup.

Durable & Low Maintenance: High efficiency gearing and lubrication systems extend service life. Lightweight, compact design for easy integration into processing lines.

Built for Clean, Demanding Environments & Safety

"The WES Series is a breakthrough for industries needing a stainless-steel gear unit that stays cool, clean, and reliable. By integrating SPIROPLAN right-angle gearing, we've created a solution that outperforms traditional gear units in hygiene-sensitive applications," said Tom Ellis, industry account specialist at SEW-Eurodrive.

Industries served include food and beverage processing (bottling, packaging and conveyor systems), pharmaceutical and cleanroom (contamination-free motion solutions) and chemical and washdown (corrosion-resistant, sealed for extreme conditions).

seweurodrive.com

PRECISE. ROBUST. AVAILABLE.

SERVO ☑ RATED

CD® Couplings

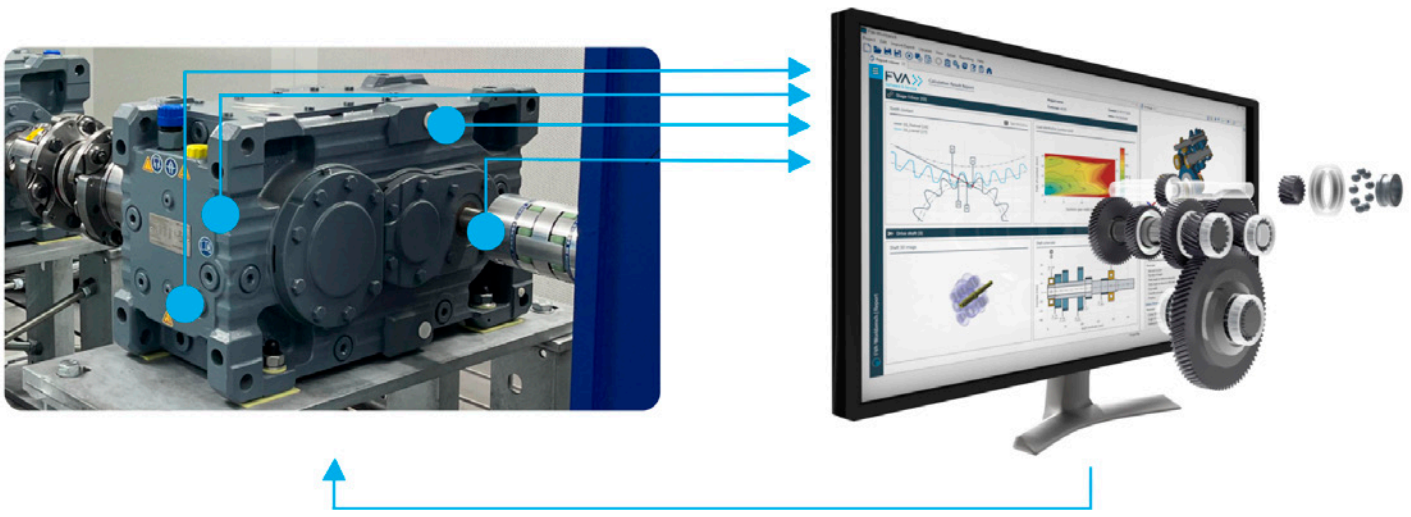
- Zero-Backlash & High Torsional Stiffness
- Engineered Performance for Reliable 24/7 Operation
- Servo-Rated for Reversing, Positioning & Precision
- Single-Flex, Double-Flex, Floating-Shaft Solutions
- Standard Models / Fully ***Customizable***
- Engineering Assistance / ~~***Fast***~~ Delivery

AUTOMATE 2025
Booth #744

www.zero-max.com 800.533.1731

ZERO-MAX®

FVA-Workbench: The Foundation for Digital Twins



Software offers efficient and user-friendly solution for creating industrial gearboxes

Michel Fett, TU Darmstadt

The digital transformation is fundamentally changing the industry, and digital twins play a central role. They enable real-time monitoring of physical systems, simulation of their behavior, and informed decision-making. A dissertation from the TU Darmstadt Institute for Product Development and Machine Elements (pmd) shows how the *FVA-Workbench* gearbox design software can be implemented as a platform for creating digital twins of industrial gearboxes. The results demonstrate how the combination of detailed modeling, continuous real-time calculations, and engaging dashboard visualization offers an efficient and user-friendly solution for the development of digital twins.

What Is a Digital Twin?

Digital twins of technical systems offer a broad spectrum of potential applications (Attaran and Celik 2023). The term refers to a digital representation of a concrete physical system. In this article, a digital twin is regarded as a digital representation of the physical model with a live data connection. During operation, sensor and operating data is continually recorded and provided to the digital twin. This data serves as input parameters for models which simulate the actual system and describe its behavior. Thus, its behavior can be calculated or simulated live, making it possible to make predictions and draw conclusions (Stark et al. 2020; Czwick et al. 2020; Wilking et al. 2021).

FVA "Digital Twin II" Research Project

The topic of digital twins and their creation is being intensively researched by the TU Darmstadt pmd together with the FAU Erlangen-Nürnberg Engineering Design KTmfk as part of the FVA 889 II—"Digital Twin II" research project. A central component of this project is developing a prototype for a digital twin of a Type X2FS100e two-stage industrial gearbox from SEW-Eurodrive *(see image above left)*. This gearbox is part of a test setup at TU Darmstadt and can be loaded with targeted speed and torque settings. Various sensors are installed in and on the gearbox to record operating data. In this case, the speed and torque are particularly relevant. The measurement data is stored in real-time on a server at TU Darmstadt.

An Overview of New Features in FVA-Workbench 10

For Related Articles Search
software
at powertransmission.com

The *FVA-Workbench* is a manufacturer-neutral solution for modeling, parameterization, and simulation of transmission systems. *Version 10* was released on February 17, 2025, to make gearbox design even more efficient.

2D Modeler: Faster and easier design changes

The new 2D Modeler makes it possible to quickly and easily modify geometries, shafts, and positions in a single plane. This is especially useful for shaft modeling: the shaft contours can be intuitively edited and modified, which greatly simplifies design and troubleshooting. Another highlight is snap and grid functionality for efficiently adjusting component positions. For example, a rolling bearing can be moved specifically to the shaft edge – the 2D Modeler automatically "snaps" the edge of the rolling bearing to the edge of the shaft, which saves time and enables precise placement of gear elements. This makes subsequent adjustments easier than ever.

Shorter calculation times thanks to modularization of ISO 10300 calculations

Bevel and hypoid gear load capacity calculations have been greatly accelerated. Standard bevel gear load capacity calculations are now up to 10 times faster thanks to modularization of calculations according to ISO 10300 – ideal for optimizations and automated calculations.

Advanced pitting calculations according to ISO 6336 and FVA 411

The local pitting calculation was extended to cylindrical gears based on findings from the FVA 411 research project. This makes it possible to determine the safety factors for each point of the flank across the mesh and compare them with damage from tests or the field.

Variant generator: Easily calculate and compare variants

The variant generator helps users to quickly calculate different gearbox variants. For example, gearing parameters or bearing concepts can be freely varied for drive optimization. The results are saved and can be easily evaluated using the new variant comparison function, allowing you to quickly find the optimum solution.

Gear skiving: Cost-effective cylindrical gear production

The gear skiving feature enables you to generate the deviation-free nominal profile for skived cylindrical gears and to calculate the gear stresses on the tooth flank and in the tooth root. This makes it possible to precisely analyze the load capacity of cylindrical gears produced with this cost-effective manufacturing process.

Bevel gear calculations: Integration of the latest calculation kernels

Bevel gear calculations can now be performed even more reliably with the new version of the software. New features enable more precise analysis and representation of tooth flank curvatures. Extended calculation options are also available, such as determination of the local flank fracture and optimization of parameters for special compensation surfaces, allowing for even more accurate contact calculations - even with flank modifications such as tip or end relief. Current standards, such as ISO TS 10300-20:2021 and ANSI/AGMA 2003-D19, have also been integrated into the software.

Quick Results View: Instant analysis of calculation results

The Quick Results View makes it possible to see key results immediately after the calculation. This allows you to immediately recognize the effects of changes to your model, enabling you to quickly determine modifications and accelerating your development processes.

Three Steps to Creating Digital Twins with the *FVA-Workbench*

The digital description and representation of the gearbox is addressed by modeling and calculation of the gearbox in the *FVA-Workbench*. This was implemented as part of William Gunawan's dissertation on "Creation of a Digital Twin through real time integration of the *FVA-Workbench*" at the TU Darmstadt pmd. The thesis was supervised by Prof. Dr.-Ing. Eckhard Kirchner and Michel Fett. The project can be divided into three steps: modeling the gearbox, establishing live calculations, and visualization in a dashboard. The following is an overview of the project and the knowledge that was gained.

Step 1: Modeling

First, the gearbox was modeled in the *FVA-Workbench*. The two gear pairs of the two-stage gearbox were used for this purpose. The geometry of the individual gears was described along with the material parameters. This includes, for example, the number of teeth (z), module (m), helix angle (b), tip diameter (d_a), and reference diameter (d) of the individual gear stages. The three shafts of the gear stages were also described by defining the material parameters, center distances, and geometries of the individual shaft shoulders, among other things. The bearings and the gear oil could be selected as standard components from the *FVA-Workbench* library. The gearbox casing was not modeled, as CAD data for the casing was not available in the project.

Step 2: Live Calculations

Typical use of the *FVA-Workbench* involves one-time simulation of the behavior and characteristics of the modeled gearbox and creating a report from the results. However, digital twin functionality requires continuous, cyclically recurring live calculations. This can be achieved using the *FVA-Workbench's* scripting feature, which can automate the execution of calculations. To do so, a script was created which uploads the latest measurement data from the sensors mounted in the gearbox to the TU Darmstadt server in 10 second increments. This measurement data includes the current torque and speed values, which are then used as input variables for calculations in the *FVA-Workbench*. Thus, the current behavior and status of the gearbox are calculated every 10 seconds.

Step 3: Visualization

Creating a results report every 10 seconds is not useful for the purpose of a digital twin. Instead, the *FVA-Workbench* exports the calculation results as *Excel* files. A live dashboard was created directly in Excel using VBA (Visual Basic for Applications), which is updated regularly with the latest calculation results and shows the current status of the gearbox. For example, the load distribution on the tooth flanks and the load ratio C/P of the bearings are visualized. The plots in the dashboard are updated after each new calculation in the *FVA-Workbench*.

The *FVA-Workbench*: A Versatile Tool for Gearbox Design and Industry 4.0 Applications

The *FVA-Workbench* goes far beyond the basic functionality of typical gearbox design software, offering a number of expansion options that increase its versatility in various application scenarios. Users can implement their own scripts to automate specific calculations and develop customized solutions. This makes the *FVA-Workbench* a key component in the lifecycle management of gearboxes. Furthermore, combining the *FVA-Workbench* with modern data acquisition methods enables deeper analysis of sensor data from physical systems. This makes it possible to detect anomalies in operation at an early stage and quickly identify the effects of system changes, which opens up new potential for predictive maintenance and machine optimization. Thus, the *FVA-Workbench* proves itself to be not only a powerful tool for the design and calculation of gearboxes, but also a foundation for innovative applications within the context of Industry 4.0. The integration of live data, for example via OPC UA, allows for more precise calculations, as measurement data for individual gearbox elements is fed directly into the *FVA-Workbench*, making it possible to perform calculations using actual data instead of just nominal values. These new models along with the evaluation of live data can be used to create digital twins which contain data from across the entire product lifecycle.

References

1. Attaran, Mohsen; Celik, Bilge Gokhan (2023): Digital Twin: Benefits, use cases, challenges, and opportunities. In: *Decision Analytics Journal 6*, S. 100165. DOI: 10.1016/j.dajour.2023.100165.
2. Czwick, Cordula; Martin, Georg; Anderl, Reiner; Kirchner, Eckhard (2020): Cyber-Physische Zwillinge. In: Zeitschrift für wirtschaftlichen Fabrikbetrieb 115 (s1), S. 90–93. DOI: 10.3139/104.112310.
3. Stark, Rainer; Anderl, Reiner; Thoben, Klaus-Dieter; Wartzack, Sandro (2020): WiGeP-Positionspapier: "Digitaler Zwilling." In: Zeitschrift für wirtschaftlichen Fabrikbetrieb 115 (s1), S. 47–50. DOI: 10.3139/104.112311.
4. Wilking, Fabian; Schleich, Benjamin; Wartzack, Sandro (2021): Digital Twins - Definitions, Classes and Business Scenarios For Different Industry Sectors. In: Proc. Des. Soc. 1, S. 1293–1302. DOI: 10.1017/pds.2021.129.

fva-service.de/fvaworkbench

PTE

Michel Fett has been a research assistant at the Department of Product Development and Machine Elements at TU Darmstadt since April 2022, where he previously completed his master's degree in mechanical and process engineering.

What's the cost of a superior system?

A lot less than an inferior one.

At **SEW-EURODRIVE,** we engineer the highest quality drive automation solutions. What truly sets us apart is our unwavering commitment to customer support, long after the sale. We go above and beyond to ensure your business stays on the move with exceptional service at every turn. **Upgrade everything.**

SCAN TO START A CONVERSATION

JOIN US AT:

→ **Robotics Summit**
Boston, MA
Apr. 30 - May 1
Booth# 212

→ **AUTOMATE**
Detroit, MI
May 12-15
Booth# 4007

→ **AAAE**
Atlanta, GA
Jun. 8-10
Booth# 1130

SEW EURODRIVE

SEWEURODRIVE.COM \ INDUSTRIAL DRIVE AUTOMATION \ ENGINEERING \ SERVICE

Humanoid Component Advancements

Schaeffler discusses motion control and robotic strategies moving forward

Matthew Jaster, Senior Editor

Schaeffler sees a significant pathway to produce precise components for humanoid robots at high volume including ball screws and strain wave gears.

Schaeffler continues to advance key technologies shaping the future of mobility and motion. One area of interest—humanoid robots—is where Schaeffler is developing advanced component and system capabilities for the next generation of robotics. *PTE* recently had the opportunity to discuss these technologies with Al Makke, engineering director, humanoid robotics, North America, at Schaeffler Group USA.

First, please tell us what the response was like at CES 2025 to Schaeffler's Humanoid Technology Exhibit?

It was good. The interactive humanoid "hologram" was an eye catcher. Several different people in the humanoid sector stopped by whether it was competitors, investors, suppliers, potential customers. The show was really effective. We must answer the question frequently, "Is Schaeffler making their own humanoids?" And the resounding answer is, no, right? We do want to showcase what we can achieve as a supplier to humanoid OEMs, however. Industry observers noted the exhibit's emphasis on Schaeffler's expanded motion product portfolio, a development bolstered by the company's recent merger with Vitesco Technologies. This strategic move has enhanced Schaeffler's manufacturing and research capabilities, positioning it as a comprehensive provider of motion solutions across various sectors. Overall, the response was positive, with attendees and industry experts recognizing the company's innovative approach to motion technology and its impact on the future of robotics.

How about the significance of the Agility Robotics investment as well as your use of generative AI across the product portfolio?

Schaeffler's strategic investment in Agility Robotics and its integration of generative AI technologies are pivotal steps in enhancing its capabilities in the humanoid robotics sector. In November 2024, Schaeffler made a minority investment in Agility Robotics, the creators of the bipedal humanoid robot, Digit. This partnership includes plans to deploy Digit robots across Schaeffler's global network of 100 plants by 2030, aiming to revolutionize manufacturing and logistics operations. The collaboration is expected to accelerate the adoption of humanoid robots in industrial settings, enhancing automation and operational efficiency.

Schaeffler has been proactive in incorporating generative AI across its product portfolio. Collaborating with Siemens, the company introduced Siemens Industrial Copilot, an AI-powered assistant designed to optimize engineering and operational tasks. This tool aids automation engineers in generating code for programmable logic controllers (PLCs) through natural language

inputs, streamlining complex programming tasks and reducing the potential for errors. Additionally, the Industrial Copilot assists maintenance teams in swiftly identifying and resolving machine errors, thereby minimizing downtime and enhancing overall efficiency.

What additional investments are enhancing Schaeffler's position in the humanoid robotics sector?

Schaeffler participates in three different ways in the humanoid sector. We are a user of humanoids in our production plants, a supplier of components to humanoid "OEMs", and a supplier of machines to humanoid manufacturers.

Schaeffler has undertaken several strategic initiatives to strengthen its position in the humanoid robotics sector:

Our merger with Vitesco Technologies expanded Schaeffler's global presence, added new manufacturing facilities, and enhanced its research and development capabilities. The integration of Vitesco's expertise has enriched Schaeffler's motion technology portfolio, enabling the company to offer comprehensive solutions essential for the development and production of humanoid robots *[Editor's note: see sidebar on page 22]*.

Schaeffler is leveraging advanced artificial intelligence and vertical integration to enhance its production technologies. A notable example is EMMA, a mobile collaborative robot (cobot) designed to improve flexibility and precision in dynamic manufacturing environments. EMMA exemplifies Schaeffler's commitment to integrating AI-driven automation solutions, which are crucial for the efficient production and operation of humanoid robots.

What are the greatest challenges for offering components for humanoid robotics?

From my viewpoint at Schaeffler as a component and joint actuator supplier, there are two key challenges.

Schaeffler offers vision sensors and machine-based learning, data analysis, localization and mapping for driver assistance systems as well as autonomous driving solutions.

CES 2025

Matthew Jaster, Senior Editor

One key highlight during my first visit to CES 2025 in Las Vegas was Schaeffler's Humanoid Technology Exhibit, an interactive display highlighting Schaeffler's key role in enabling motion through advanced robotics. During the show, Mike Paschke, industrial automation national sales manager, gave our group a comprehensive tour of the exhibit—highlighting how Schaeffler is shaping the next generation of robotics from a component as well as a system level.

"Basically, there's eight new motion technology families," Paschke said. "This breaks down into the full portfolio of products Schaeffler can offer. The idea here being each of these building blocks really comprises the full system. Now as a company we must start thinking about battery technology, sensors, power electronics for humanoid robots, and how these system capabilities translate to high volume manufacturing."

The merger with Vitesco Technologies, completed on October 1, 2024, expands Schaeffler's presence globally, adding new manufacturing plants and boosting the company's research and development capabilities. Schaeffler's solutions now cover the entire spectrum of motion, from power transmission to energy generation and sustainability, allowing for a seamless integration of technologies. Especially in the field of electromobility, Schaeffler can now offer customers a comprehensive product range and can therefore derive even greater benefit from the growth potential in the electromobility market.

Schaeffler's Dynamic Performance Vehicle at CES 2025 highlighted the full range of technologies for chassis systems and electrified powertrains, augmented by the addition of Vitesco Technologies. The company can now deliver a battery electric vehicle solution, featuring all vital components and systems required for a complete electrified powertrain. The interactive exhibit demonstrated these solutions–from components and systems for light passenger cars to heavy-duty applications.

First, the industry is rushing to find the right actuator architectures and performance for each joint. This is resulting in very different joint designs and architectures (rotary vs. linear actuators and even more diverging solutions within the rotary actuator family and the linear actuator family). The only apparent consensus now is strainwave gear-based actuators which virtually every humanoid OEM is using in at least some joints. There's a large focus on performance, and if the "ChatGPT moment for general robotics is truly around the corner" and that humanoids will truly reach the volume projections that we hear about, then we must start thinking about scaling these components for high volume production. Schaeffler's background in high volume production for the automotive industry in combination with our understanding of these new joint actuator requirements will give us a good seat at the table to address these challenges.

Second, we must understand as an industry the unique requirements of humanoid robots and how they differ from traditional robots. Right sizing the requirements will enable us to explore high volume solutions that will support the bullish outlook on the market.

What role do bearings play in these applications, and why is a customizable approach so critical?

Lightweight, high torque density, and low friction will continue to be important for smooth humanoid control and battery life management. Customized bearings might be necessary in certain actuators and certain positions, but it's wise to pursue standardized solutions where possible especially when we talk about mass production in the coming years.

How do the components Schaeffler provides compare to hydraulic or pneumatic systems?

Increased Precision and Control: Electric actuators offer finer control over movement, making humanoid robots more adaptable to complex tasks. Hydraulic systems, while powerful, can be difficult to precisely regulate due to fluid dynamics.

Lower Maintenance and Complexity: Hydraulic systems require pumps, valves, and high-pressure fluid lines, leading to potential leaks, high maintenance requirements, and complex routing. Electric actuation simplifies the design, reducing maintenance needs.

Better Energy Efficiency: Hydraulic systems consume more power due to continuous fluid circulation, whereas electric actuators use energy more efficiently by only consuming power when needed.

Reduced Weight and Space: Hydraulic systems require large reservoirs, hoses, and pumps, adding weight and bulk. Electric actuators allow for a more compact and lighter design.

Scalability for Practical Applications: Moving towards electric actuators aligns with broader industry trends, making the technology more viable for real-world applications in logistics, manufacturing, and other fields.

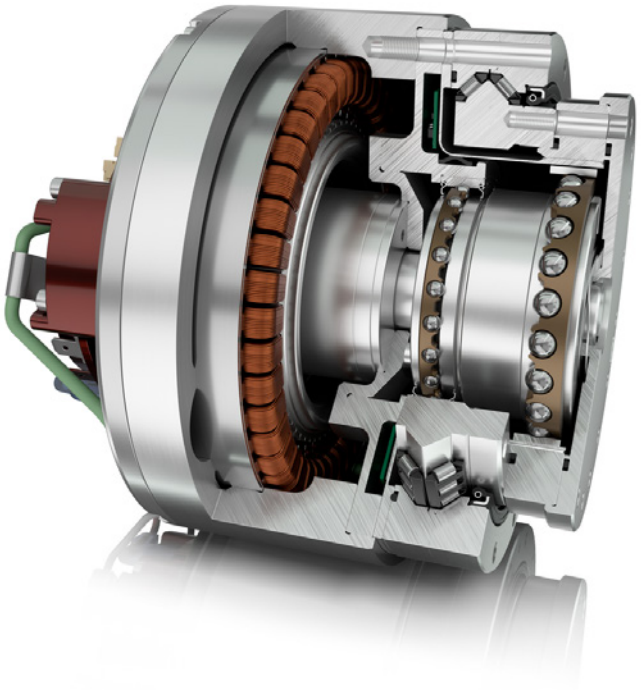
This shift reflects a broader movement in humanoid robotics, where electric actuation is becoming the preferred standard for its balance of power, efficiency, and scalability.

Humanoid robotic components are getting smaller. Can you discuss a few advantages to agility, sustainability and efficiency with smaller drive technology?

The trend toward miniaturization in humanoid robotics is unlocking higher agility, lower power consumption, greater sustainability, and cost reductions, making humanoids more practical, scalable, and efficient for real-world applications. As compact actuators, motors, and reducers

Schaeffler's Humanoid Technology Exhibit was a booth highlight at CES 2025 in Las Vegas.

Part of Schaeffler's "Guide Motion" family of products and solutions: thin section bearings.



Part of Schaeffler's "Generate Motion" family of products and solutions: rotary actuator.

For Related Articles Search
robotics
at powertransmission.com

continue to advance, humanoid robots will become faster, more dexterous, and more widely adopted across industries. In general, lighter humanoids are faster.

What additional areas outside of humanoid robotics can benefit from this type of electromechanical actuation?

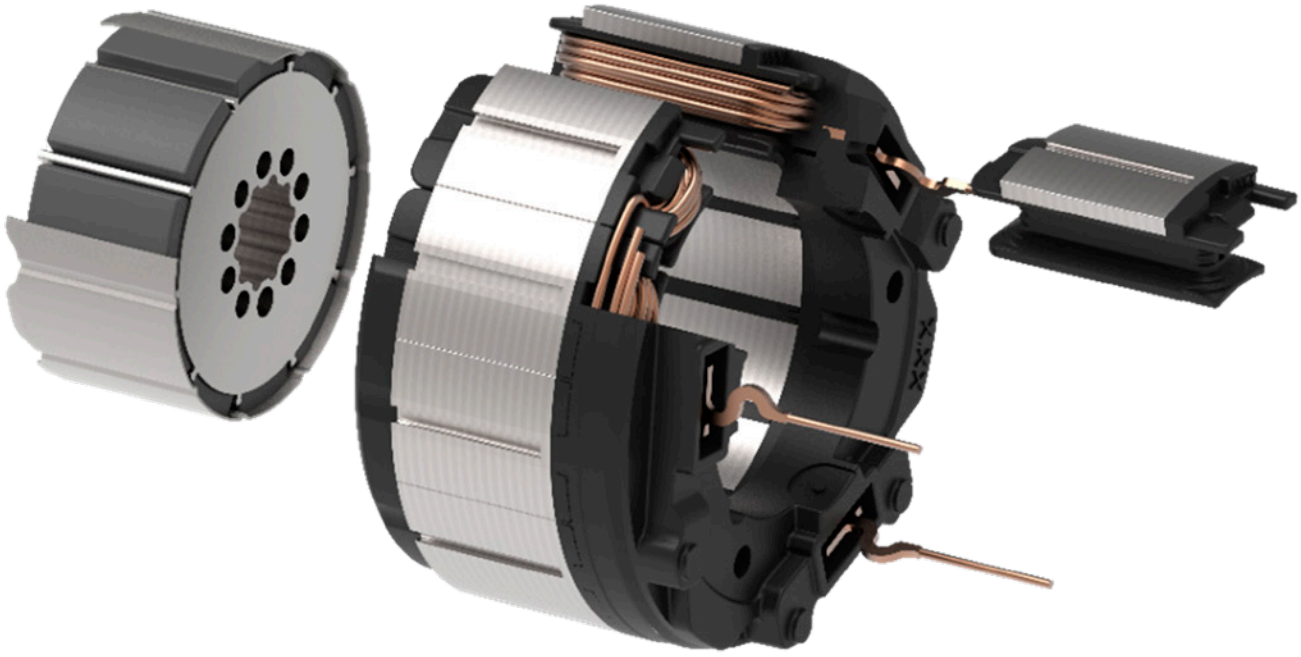
I already see a lot of parallels between humanoid actuators and automotive active suspension actuators. With L3+ autonomous vehicles in our future, comfort requirements are increasing and approaching humanoid actuators in the legs and arms from a requirements standpoint. can think of a few other applications that would have similar requirements for actuator bandwidth, back drivability, safe state, etc.

Why is Schaeffler's system design approach so important moving forward?

Based on the automotive suspension parallel, I would extend your question to include automotive and e-Mobility applications. I think we have the tools and business processes to pull ideas from various parts of our business to develop holistic solutions and not just component solutions. We've seen such successes in a short period of time with transforming current sensor technologies from ex-Vitesco into relevant force sensors for humanoid actuators, and we have many similar irons in the fire right now. I think our humanoid display at CES is going to evolve significantly over the next couple of years.

How will humanoid and industrial robotic applications evolve in the coming years?

Based on Morgan Stanley's "The Humanoid 100" report, the evolution of humanoid and industrial robotic applications in the coming years will be shaped by advancements in AI, automation, semiconductor technology, and supply



Part of Schaeffler's "Drive Motion" family of products and solutions: brushless DC motors.

chain development. Here are the key trends and expectations:

We'll see the expansion of humanoid robotics from prototypes to real-world applications in areas such as manufacturing, logistics, and healthcare. Humanoids will be integrated into factories, warehouses, and customer service, assisting in tasks that are physically demanding or require fine motor skills. Humanoid OEMs are leading the push toward practical humanoid robots that could be deployed at scale.

AI models will enhance humanoid robots' ability to learn from human demonstrations and adapt in real-time. Additionally, the increased use of vision-based AI, LiDAR, and force/torque sensors will improve robots' ability to interact with complex environments. Digital twins and reinforcement learning will accelerate training, allowing humanoids to perform real-world tasks with minimal human intervention.

We'll also see improvements in battery technology. Battery companies are working on high-density, long-life lithium-ion batteries to power humanoid robots efficiently. The transition from hydraulic to all-electric humanoids (e.g., Boston Dynamics' new Atlas) will improve energy efficiency and enable longer operating times.

While China currently dominates the robotics supply chain, particularly in motors, semiconductors, and rare-earth materials, western companies are investing heavily to catch up. In the next 5–10 years, humanoids could become as commonplace in workplaces as industrial robots are today, reshaping labor markets and productivity worldwide. However, the key path to scalable humanoids is ensuring safe operations along side humans anywhere; whether that's at the workplace or at home. This will expand the possible use cases significantly.

Is there anything you'd like to add about Schaeffler's components in the humanoid robotic industry?

Schaeffler is widely perceived as a component supplier in the humanoid robotic industry, and that is apparent in some of the market research studies that have been produced over the last couple of years. We have furthered our product portfolio significantly in e-Mobility, powertrain and chassis, as well as humanoid robotics where we can leverage our "Motion Families" to ideate and produce high value actuators for our customers. From sensors, transmissions, bearings, and software to completely integrated actuators and controllers, we have a robust product portfolio that is supported by our vertical integration to make a difference in the humanoid robotic sector, and we're nothing short of excited about playing our role.

`schaeffler.us`

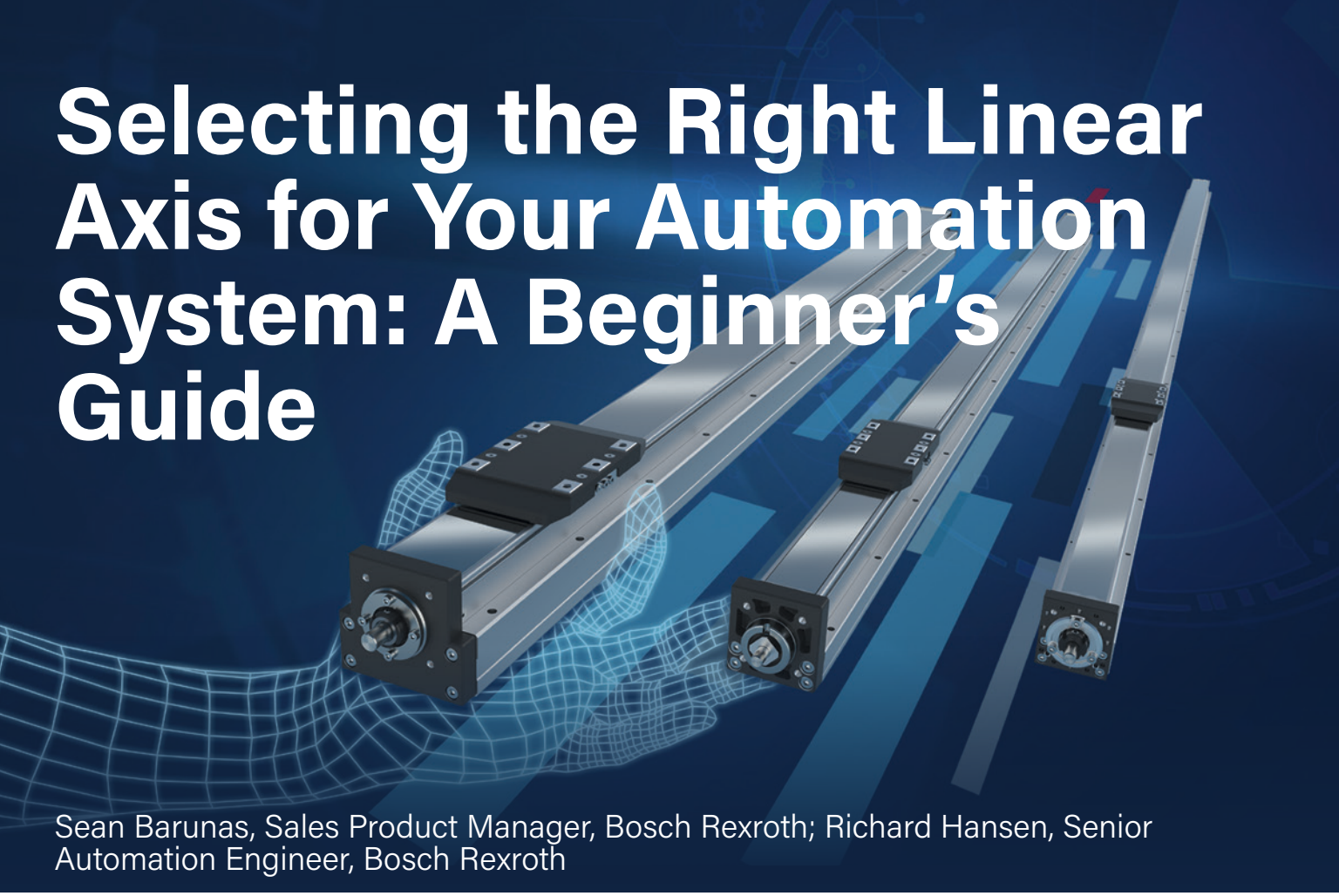
PTE

Additional Resources:

"Actuation Challenges in Robotics Today" (*PTE* June 2023)
`powertransmission.com/actuation-challenges-in-robotics-today`

"Planetary Gear Rethought" (*PTE* online article April 2023)
`powertransmission.com/planetary-gear-rethought`

Selecting the Right Linear Axis for Your Automation System: A Beginner's Guide



Sean Barunas, Sales Product Manager, Bosch Rexroth; Richard Hansen, Senior Automation Engineer, Bosch Rexroth

Foundational to factory footprints across a breadth of industries and applications, linear motion systems and the axes they operate on remain critical components that OEMs and end-users rely on daily. As diverse as their use cases, linear axes are not a one-size-fits-all solution and, as such, need to be configured and leveraged properly to ensure optimal performance. Manufacturers and end-users should view this article as a roadmap to understanding linear axes and how they'll continue to play a key role in manufacturing and logistics applications in the future.

Transparent Evaluation

At the heart of any successful manufacturing operation is a culture of consistent, transparent evaluation. Managers need to have a thorough comprehension of all processes and should constantly monitor performance to identify opportunities for improvement. While legacy processes are typically the foundation for meeting objectives consistently, it's worth exploring modern and advanced technology to further improve productivity. Linear axes can be applied to a variety of processes and should be considered as a potential solution for many manufacturing needs.

When evaluating axes' integration with a process, manufacturers need to first identify a clear objective regarding speed, payload, and accuracy. How will the actuator(s) move objects safely and effectively to align with an established goal? Equally as important as reaching current

Software today has streamlined the design phase, allowing end-users to digitally build their custom linear motion solutions.

throughput metrics is considering future needs as well. What's the range that may be required of the axes so they can adjust to meet shifting objectives? Having a clear understanding of those parameters will help narrow down the type of axes that may be required.

Additionally, having an understanding of an objective can help manufacturers avoid unnecessary and complex requirements. While linear axes are an inherently simple solution, some manufacturers can complicate their implementation by overengineering them for applications that aren't aligned with their design. This can hinder an entire process and lead to higher costs, longer lead times, and project delays.

Design At Your Fingertips

One of the most important advancements in implementing linear axes solutions is how they're being selected by the end-user. Previously, individual components may have been chosen out of a catalog, and sometimes, a follow-up call was conducted to confirm what it was being used for. The process was imperfect, as it was susceptible to miscommunication that led to incorrect specifications for a solution, or one not perfectly designed for a task.

Now, modern software has streamlined the design phase, as many end-users want to digitally build their custom linear motion solution themselves and see a CAD model designed to their exact specifications. They can avoid selecting unnecessary components and easily cycle through multiple solution options before making a final selection. This speeds up the process of getting the solution into the end user's hands, which can have a faster impact on overall productivity.

Selecting the best linear axis should be based on the application requirements, load capacity, speed and precision.

While the initial design phase rests mostly on the customer, it's still important to maintain a relationship with the supplier. Within certain verticals, linear motion solutions are trending towards established standards, and suppliers need to provide direction to end-users on whether their solution is aligned with how other end-users may be integrating similar technology.

Not surprisingly, the digital development of linear motion solutions falls in line with the overall digitalization of manufacturing processes. End-users who embrace this transition are positioning themselves as attractive employers to the younger generation of workers who are utilizing digital technology in their daily lives.

An Evolutionary Environment

Advancing in parallel to the digitalization of manufacturing is the design of linear axes themselves. Because many OEMs and end-users are trending towards a fully automated operation, linear axes are being leveraged for a greater variety of tasks and must evolve to meet those needs. There's a consistent push to move objects faster and more accurately, as well as an increasing need to accommodate heavier payloads. A key example of this is battery manufacturing, which remains in the spotlight as the global EV industry continues to grow. Heavy battery modules need to be produced at faster speeds to meet demands and linear axes must be able to transport them effectively and repeatedly while bearing a heavier load.

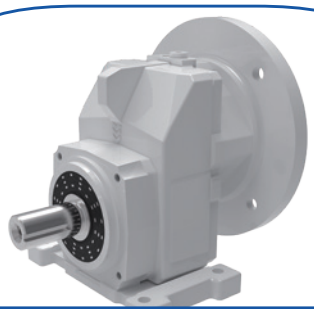
Here to stay

While there are a variety of solutions within manufacturing, linear axes continually prove their worth in their breadth of applications and longevity of effectiveness. OEMs and end-users need to fully understand their capabilities, especially in greenfield environments, before implementing or integrating them. Furthermore, modern design software allows customers to design axes and solutions to their exact parameters, which ensures they're getting the exact one they need and in a timely manner compared to the catalogs and phone calls of previous generations. This allows operators to maintain productivity with a proven solution that will remain a key component in the manufacturing industry as it evolves to meet emergent needs.

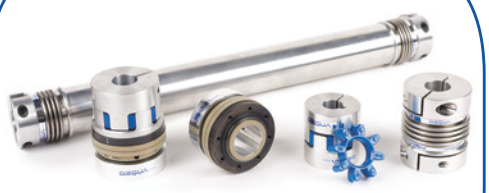
boschrexroth.com/en/us/

When off the shelf just won't do.

With our extensive range of standard components and custom machining capabilities, a custom-designed and manufactured gearbox for specific applications is something we do all the time.

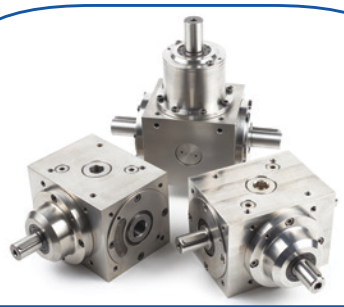


FDA Paint



Stainless Couplings

Stainless Spindles



Stainless Housings

DIEQUA Corporation

180 Covington Drive
Bloomingdale, IL 60108 USA

630-980-1133

www.diequa.com

Motion Control and Power Transmission Drive Components

New Dynamics in Automation and Motion Control

Automate 2025 boasts robotic ingenuity and efficiency

Matthew Jaster, Senior Editor

Automate 2025 takes place May 12-15 in Detroit.

Curious about the state of robotics and automation? A day or two at Huntington Place in Detroit this spring should clear everything up. Automate 2025 attendees might see robots serving coffee, robots maintaining shop floors, robots building other robots. We have officially crossed the threshold from future possibility to practical application.

Between intimate workshops with industry giants, keynotes, networking events, innovation competitions and live demonstrations, Automate offers comprehensive automation education and robotics, vision, AI, motion control and other technologies. Automate delivers the latest innovations in manufacturing automation technology from more than 800 leading exhibitors.

Future of Motion Control Technology

The Automate team says companies across industries are using AI to revolutionize motion control technology. ABB, Siemens, and FANUC are integrating AI into their industrial robots and control systems, enabling more intelligent and responsive movements in manufacturing processes.

Epson Robots, in partnership with Motion Ai, is integrating AI-driven solutions into their robotics systems, enhancing precision and adaptability in automation applications for semiconductor, pharmaceutical, and logistics sectors.

New encoder technologies are providing medical machine manufacturers with expanded options for position sensing and data transmission. Delta robots like the KUKA KR DELTA can achieve cycle times as fast as 0.32 seconds with high precision in pick-and-place operations for industries such as food and pharmaceuticals (*automateshow.com/blog/motion-control-101-fundamentals-and-emerging-trends*)

Automate 2025 offers 800+ exhibitors, 200+ speakers and 140+ conference sessions.

Advancements in AI

AI models are becoming increasingly capable of making real-time decisions. This has accelerated investment in edge computing, allowing businesses to automate processes faster and more intelligently than ever before. The Automate team examined these new technologies with Siemens and OnLogic:

The Rise of Private 5G Networks

Edge computing and private 5G networks go hand in hand. Companies like Ericsson are deploying 5G-powered edge solutions to enable seamless machine-to-machine communication, improving automation capabilities across industries.

Demand for Sustainability and Energy Efficiency

Localized data processing significantly reduces the energy consumption associated with cloud operations. Companies such as Schneider Electric are leveraging edge computing to optimize energy use, reinforcing its role in sustainable industrial automation.

The Growth of Industrial IoT (IIoT)

Smart factories and connected supply chains are becoming the norm. Edge computing enables IIoT applications to function with minimal latency, ensuring smooth and efficient automation processes.

Robotic Technology

Whether you're looking to streamline your production line, tackle labor shortages, or make your workplace safer, robots are a powerful solution—and ally. The Automate Team is here to help with a list of common robot types, from traditional industrial robots to innovative collaborative and mobile robots. Examples on display at Automate 2025 include:

Cylindrical Robots

These robots combine rotational movement with vertical and horizontal motion, operating within a cylindrical workspace. Their versatility shines in various applications across the manufacturing floor. They excel in machine tending operations, assembly processes, and material handling tasks. Their design makes them particularly effective for packaging, palletizing, and precision dispensing operations where consistent circular motion is required.

Collaborative Robots

Cobots represent the next evolution in industrial automation by working directly alongside human workers, unlike traditional robots that are confined to cages. They are ideal for quality inspection, assembly lines, and packaging or material handling. You can choose between 4 major types of cobots: Safety Monitored Stop, Speed and Separation, Hand Guiding, and Power and Force Limiting. These cobots use sophisticated collision sensors and force limitations to detect when they contact a human worker. This helps them to stop and avoid any injuries.

Autonomous Mobile Robots (AMRs)

These intelligent robots navigate independently using sophisticated sensor systems and AI. Their

advanced capabilities provide significant operational benefits. With dynamic obstacle avoidance and flexible routing capabilities, they can adapt to changing environments without requiring infrastructure modifications. Their sophisticated systems enable seamless integration with existing operations, making them a versatile solution for modern manufacturing facilities, warehouses, and even healthcare facilities.

Automated Guided Vehicles (AGVs)

AGVs are robots that follow predetermined paths, providing dependable and error-free transport of materials within a facility. They offer safe and efficient material transport, reducing human error and improving accuracy in tasks like moving heavy items across warehouses and distribution centers.

Drones (UAVs)

UAV stands for unmanned aerial vehicle but is more commonly known as a drone. These aerial robots can assist with surveying, inspections, and deliveries. Since they can take to the skies to see hard-to-reach areas and deploy quickly, they are ideal for complex terrains or challenging environments. In fact, they are becoming increasingly popular in industries like construction, logistics, infrastructure, and energy.

Service Robots

Service robots are as diverse as the environments where they assist operations. From industrial applications to specialized fields, they are designed to perform tasks that assist humans in daily or dangerous activities. These include humanoids, customer service, exoskeleton, inspection, agriculture, and medical robots.

Booth Previews

PTE readers will be interested in many of the component and motion control exhibitors at Automate. The following is a shortlist of must-see exhibitors and technologies. Editor's Note: Booth numbers and companies are subject to change prior to the trade show.

Zero-Max

Booth #744

Zero-Max provides high-performance flexible shaft couplings, overload safety couplings, right angle gear drives, keyless shaft bushings, overhung load adaptors and other precise motion control components. The company will display the latest mechanical power transmission and motion control products at Automate 2025 in Detroit.

Zero-Max also provides the Miki Pulley brand of spring actuated brakes and electro-magnetic brakes and clutches ideal for the growing robotics, AGV, and AMR industries. Featuring the fastest delivery in the industry and extensive custom capabilities and expertise, Zero-Max is known throughout the World for innovative designs, high quality, high performance, and durability. Zero-Max and Miki Pulley products solve applications in automated assembly machines, autonomous mobile robots, material handling equipment, conveyors, automated workholding, motion control equipment, and other high performance industrial machinery.

"Automate 2025 is the ideal setting for us to demonstrate our latest advancements and interact with industry professionals looking for automation solutions," said Brian Mishuk, vice president of sales and marketing at Zero-Max. "We are excited to meet with attendees and preview how the Zero-Max and Miki Pulley products can solve their motion control needs. See us at Booth #744."

zero-max.com

ASI Drives

Booth #6203

For 40 years, ASI Drives has been providing quality tailored engineered solutions to the gearmotor industry. As a full-service engineered products company, ASI Drives offers a range of gearmotor solutions designed for battery-operated products up to one ton in weight. From robotic floor cleaning machines to outdoor field robotics, warehouse AGVs and AMRs, wheeled mobility solutions and many others—ASI Drives provides the traction solution to keep them moving. Located in Montgomeryville, PA—about 45 minutes outside of Philadelphia—we are proud to provide American-made products for our customers from all over the world. Products include autonomous mobile robots (AMRs), mobility solutions, motors, actuators, mobile robots and design and engineering services.

asidrives.com

Beckhoff Automation

Booth #2400

Beckhoff empowers engineers to differentiate and succeed as industry leaders—to harness new technologies, embrace open standards, and solve the world's most complex problems. Founded and led by engineers, the company organically creates advanced controls, communication, IoT, and motion technologies that become unique tools in an age of digital transformation.

beckhoff.com

Freudenberg-NOK Sealing Technologies

Booth #4839

Manufacturers are using smaller, faster, and more efficient robots and

cobots to improve production efficiency and make operating conditions safer and easier for workers. These advanced automation systems also must endure extreme temperatures and harsh chemicals, all of which require greater sealing performance. Freudenberg offers comprehensive sealing solutions for all types of robots, in all conditions, facing all challenges. Excellent seal effectiveness prevents leaks and the resulting machine breakdowns—reliably and lastingly. Costly downtime is eliminated, and service and repair expenses are reduced.

fst.com

Bishop-Wisecarver
Booth #4713

Bishop-Wisecarver (BW) develops reliable motion solutions expertly designed and delivered to perform. BW is a U.S.-based, certified women owned company, with over 70 years of experience. The company offers complete linear and rotary motion solutions that excel in extreme and harsh environments and can be found in virtually every industry of industrial automation. Products include motion control equipment, power transmission, actuation, mechanics and industrial robots.

bwc.com

Siemens Industry, Inc.
Booth #3232

Siemens will offer attendees the combined power of software and automation. The booth will highlight the most advanced solutions to help companies make a giant leap in their digital transformation—without the need to rip and replace. Technologies include robotic integration, virtual control, IT/OT data integration and everything it can power, copilots for operation and maintenance, AI visual quality inspection, AI prescriptive maintenance, cybersecurity in automation, digital twins and advanced simulation tools.

siemens.com

Destaco
Booth #2807

Destaco will showcase its cutting-edge automation products and solutions designed to enhance efficiency, precision, and productivity in manufacturing and industrial settings. Visitors can experience firsthand how Destaco's innovative gripping and tool-changing solutions revolutionize automation processes across various industries.

"Automate 2025 provides a fantastic platform for us to demonstrate our latest advancements and interact with industry professionals seeking state-of-the-art automation solutions," said Ravi Shivanna, director, global new product development engineer at Destaco.

destaco.com

Iris Dynamics Ltd.
Booth #6207

Iris Dynamics Ltd., a leader in innovative motion control solutions, is proud to announce its latest product, ORCA-3: the smallest, fastest, and most cost-effective motor in the ORCA Series. Developed in response to a growing demand for a more affordable and compact solution, the ORCA-3 is set to revolutionize cost-conscious design while upholding the high-performance standards of the ORCA product line. It is priced below $1,000 for volume orders.

The ORCA-3 combines compact design, high speed, and cost efficiency, while maintaining full compatibility with the ORCA Series for seamless integration in space-limited and budget-conscious applications. It is ideal for OEMs, machine builders, and integrators working on research and product development projects, offering easy integration and scalability. With minimal changes to mechanical, electronic, and software components across the ORCA Series, engineers can design with the ORCA-3 and easily migrate to more advanced models as project requirements evolve. This adaptability enables rapid prototyping and iterative development. Key product features include its compact size, high speeds of 6.5 m/s, and affordability.

Full Integration: The entire line of ORCA electric linear actuators combines integrated power delivery, motor drivers, logic, and sensors, all calibrated during manufacturing. This design enhances performance, simplifies integration, and reduces installation overhead by eliminating separate components.

Force Control: Inherent force control enables ORCA motors to sense the force they impart, a critical safety feature in applications where force may be exerted on a person. The motor can detect when it encounters an object, allowing it to back off or apply lower force as needed.

Silence in Actuation: With some of the quietest motors on the market, ORCA motors support seamless integration into shared environments, enhancing safety and reducing fatigue in industrial settings.

Smooth, Consistent, Cogless Motion: ORCA motors deliver smooth, consistent, and cogless linear motion, ensuring uniform force and enhanced precision. Fully backdrivable, ORCA motors can be moved manually without resistance when powered off, offering flexibility and ease of use across various applications.

irisdynamics.com

It's Educational

The Automate 2025 exhibition floor is more than enough to keep attendees busy throughout the week, but the comprehensive conference agenda adds even greater value. Topics in 2025 include AI and machine learning; HMIs for 21st–century factories; vision, imaging and inspection; 5G capabilities, robotic integration, ISO standards, automotive assembly, motion control accuracy and much more.

automateshow.com/agenda

Autonomous Inspection

Boston Dynamics Spot levels up into condition monitoring and maintenance fieldwork

Matthew Jaster, Senior Editor

For a few years now, Spot—the agile, mobile robot—has been surveying show floors at Automate, CES and Promat. Last year, Boston Dynamics presented a slew of additional technologies at IMTS 2024, showcasing robotic innovations key to scaling autonomous industrial inspection for components such as bearings, motors, pumps, gearboxes and conveyor systems.

Industrial inspection

Many *PTE* readers have discussed employing AI technologies to tackle shop floor challenges in the coming years. An AI-enabled facility allows management to make better, faster decisions, improve safety and efficiency, and most importantly, reduce overall costs. Boston Dynamics believes the key to this evolution is capturing consistent and reliable data. These robots can now work with minimal variations to deliver frequent and accurate inspection results. Here are a few of the latest technologies, giving companies an opportunity to reduce unplanned downtime and prevent critical failures in the future:

Thermal inspection

Spot can collect thermal images of pumps, motors, and electrical equipment with pixel-level temperature data. Users can set up alerts when equipment exceeds a set range or when temperature differences between assets surpass thresholds.

Acoustic inspection

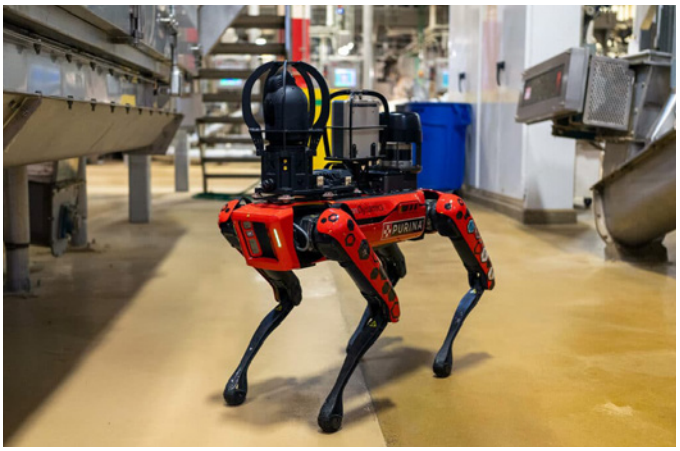
Noise anomalies can be an early indicator of impending equipment failure, but leaks, vibrations, and electrical discharge are typically undetectable by people. Acoustic inspections with Spot enable users to autonomously monitor sound signature changes to prevent unscheduled maintenance. Utilizing the Fluke Sv600—a fixed acoustic imager translating sounds into a visual representation to locate problem areas in factory systems—Spot can locate costly leaks in compressed air and gas lines, record acoustic images and videos for post-inspection analysis and alert MRO teams to maintenance issues.

Gauge reading

Spot uses machine vision models to read and analyze analog gauges that measure pressure, flow, and more. It can trigger alerts for abnormal readings and track asset trends over time.

Application examples

Nestlé Purina deployed Spot to automate thermal and acoustic inspections in their packaging lines. Autonomous inspections allowed Nestlé Purina to give time back to the maintenance technicians, better predict and plan repairs, and ensure reliable operations.



Nestlé Purina incorporated Spot into its maintenance routine to automate thermal and acoustic inspections on the factory floor.

"In the case of Spot and the case of freeing up that manpower to be able to work, if Spot can find these issues for us in between our changeovers in between different production runs, we're able to catch those issues ahead of time that allows us to be more predictive, more preventative rather than reactive," said Scott Smith, Nestlé Purina.

"We don't see Spot as just thermal and acoustic inspection. We see Spot as something more of a tool that we can use for other applications. And we're just starting to explore that and see what we can do in collaboration with Boston Dynamics to make Spot even more useful for our factories," added Alyssa Carter, senior specialist, robotics engineering at Nestlé Purina.

The company has spent some time on digital transformation and saw added value in the use of acoustic compressed air leak detection moving beyond regular predictive maintenance.

The Anheuser-Busch InBev (AB InBev) brewery in Leuven, Belgium took Boston Dynamics' Spot robot on a test run in 2022 to see how many mechanical issues or air leaks it could find in the sprawling facility. Less than two hours later, they were ready to offer the robot a full-time job.

Since this test run Spot has become a key part of AB InBev's "Brewery of the Future" program, which invests in emerging technology to support the company's ambition of achieving net-zero operations at the Leuven facility by 2028.

Spot conducts 1,800 individual inspections each week across ten packaging lines that churn out over 50,000 containers of Stella Artois, Budweiser, and Corona beer

every hour. In its first six months of deployment, Spot discovered nearly 150 anomalies and slashed average repair times from a few months to a mere 13 days.

"Our machinery experiences a lot of wear over time, so predictive maintenance is a top priority," said David Gregory, scale and innovation manager at AB InBev. "Spot is seeing more than double the anomalies we were expecting, but we're also now able to make repairs and see performance increases and energy reduction within the brewery."

With local roots dating back to 1366, the Leuven facility is world famous for its age, as well as being one of the largest breweries in Europe. Established in 1992, the facility covers the equivalent of 30 soccer fields, with four brewing houses and over 800 employees.

The packaging floor is a labyrinth of stainless-steel piping and conveyor belts that move bottles and cans through the filling and packaging process. Intricate machinery—including pumps, compressors, gearboxes, and conveyor motors—are critical for production.

At this scale, any mechanical issue that threatens to slow or halt production is a major concern, especially since the packaging lines operate around the clock when not under repair. Preventing unscheduled downtime means identifying mechanical problems before they reach critical failure.

"It is very important for us to make sure a line does not shut down at unexpected times due to crashes or errors on our machines," said Yentl Degeyter, FP&A manager at AB Inbev. "We can only achieve zero downtime by ensuring we can predict when a particular machine will exhibit faults so we can perform our maintenance in advance."

Spot initially caused quite a stir during its first weeks of deployment in early 2023. Employees responded with a mixture of amazement and curiosity, treating Spot like a celebrity. However, over time, employees came to consider the robot more of a colleague than a machine.

For Related Articles Search
condition monitoring
at powertransmission.com

Spot conducts 1,800 individual inspections each week across ten packaging lines that churn out over 50,000 containers of beer at the Anheuser-Busch InBev in Leuven, Belgium.

Spot focuses on two types of inspections: thermal and acoustic. When mechanical parts begin to wear out, they tend to generate heat. Spot uses a thermal camera to provide visual evidence of excess heat emanating from problem areas. Spot simply points the camera up at a specific piece of equipment and captures an image.

In one case, Spot identified a faulty transport motor that would have shut down a packaging line for at least six hours. Spot has also discovered gearboxes low on oil and faulty motor fans. By performing these tedious, repetitive inspections, Spot frees up staff to focus on repairs.

As for air leaks, Spot uses a Fluke SV600 acoustic sensor that identifies the characteristic sound frequencies produced when compressed air escapes under pressure. Prior to Spot, the maintenance team had to shut down entire packaging lines to listen for leaks. Spot can identify leaks amidst the hum and clatter of normal operations.

"We're identifying things that even when you're standing right next to it, you can't hear it because the background noise is just covering up that decibel," said Gregory.

Many anomalies Spot finds are leaks of compressed air and other gases, the cost of which adds up quickly the longer they remain undetected. For example, Gregory estimates the average cost of an air leak as $550 in wasted product. Leaks of ammonia and other expensive gases can create losses of up to $15,000. Even when staff can smell a gas leak, Spot can find the exact location within seconds.

"One day the safety department called asking if Spot could help them pinpoint a very small ammonia leak," said Gregory. "Spot found it and we repaired it instantly. Ammonia is something like ten times more expensive than CO_2."

Two small teams have received training to operate Spot. The brewery has several zones, each with a designated "robot wrangler" who identifies inspection points and programs the robot's missions. Gregory says anyone who can play a video game can learn how to operate Spot in less than 15 minutes. Creating a mission is as easy as maneuvering Spot to a given point along a production line and using a multitouch tablet to set and name an action.

"You can create a simple mission in five minutes or a complex mission with 50 or 40 inspection points in under one hour," said Gregory. "The advantage with using Spot is that we're able to continuously and accurately reproduce the same measurements—and keep reproducing those results—day in, day out."

The Value of Autonomy

According to Boston Dynamics, thousands of Spots have been deployed around the world inspecting a million industrial assets. They can traverse hard to reach or inaccessible spaces on the factory floor or inspect hazardous machinery so vital workers can stay out of harm's way. This is the future of condition monitoring and predictive maintenance where machines take on dirty, dull and dangerous jobs so MRO teams can focus on plant efficiency and service support.

youtube.com/watch?v=9pZQ29RSz4I&t=202s
bostondynamics.com

Advanced Lubricant Technology for Open Gear Applications

Dr. Jennifer Clark, Ph.D., Dr. Robert Dura, Ph.D., CLGS, Roberto Saruls

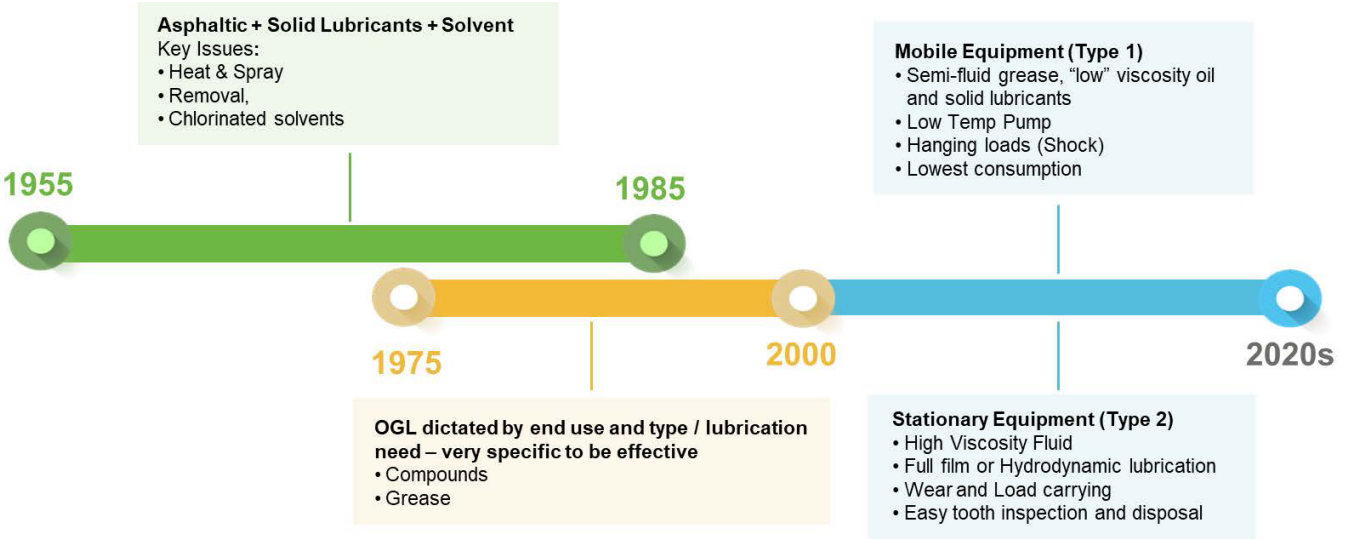


Figure 1—Evolution of OGLs.

Lubricating greases are typically known for their use in a wide variety of applications such as rolling element bearings, automotive transmission joints as well as heavy duty chassis components; but can also be found very useful in the lubrication of gears. There are two types of gear families: the primary difference being open and enclosed gearboxes. The gears within a closed system are lubricated with grease within the system. Open gears are lubricated by grease or fluid separate from the piece of equipment. In 1938, AGMA published a tentative draft specification covering the lubrication of both open and closed gears (Ref. 1). This was approved by the AGMA Lubrication Committee in 1946. The most recent version of this standard was from 2016 and was re-issued in 2021 (Ref. 2). Independently of AGMA, there are now multiple specifications for lubricants, both liquid and lubricating greases for enclosed gearboxes. This paper will focus on the lubrication of open gears, utilizing both grease and fluid Open Gear Lubricants (OGL).

Mining, sugar, paper, textile cement and food production are just some of the applications that utilize OGLs that provide to meet stringent lubrication requirements that include increased base oil kinematic viscosity, high load-carrying, good antiwear properties, pumpability, environmental acceptability, low consumption rates, adequate corrosion protection amongst other secondary requirements (Ref. 3).

Since industrial applications demand stringent requirements for these lubricants, OGLs have evolved through time since their conception in the 1950s (Figure 1). Since their introduction, the traditionally applied OGLs were asphaltic type products which evolved into sprayable asphaltic cut back products. These OGLs were typically formulated with high kinematic viscosity mineral oils that contained high levels of asphalt or bitumen combined with a volatile solvent diluent.

These lubricants were typically applied by spray systems and as the meshing action of gears began, the solvent would evaporate off, leaving behind a viscous lubricant. Cutback solvents were predominantly chlorinated such as 1,1,1-trichloroethane because they were rapid to evaporate, had high flash points and improved the efficacy of spray application. This type of OGL was popular from the 1950s until 1995 when the Montreal Protocol put a global ban on ozone depleting substances in commerce (Ref. 4). These OGLs also caused housekeeping problems because at higher temperatures they would readily oxidize, harden and cause lubricant buildup. At lower temperatures, these lubricants became difficult to dispense and would stiffen, crack and peel-off, leaving gears unprotected (Figure 2).

Figure 2—Asphaltic OGL applied to open gears.

Base Oil Selection

As open gear lubricants evolved, base oil selection became a crucial part in formulation. When selecting a base oil for OGLs, many variables need to be considered, such as: end use application, operating temperature and desired environmental profile base oil. Understanding the end use and whether they will be operating under fluid film, boundary or mixed lubrication conditions is very important. Traditionally, film thickness and strength were considered critical and drove the use of higher kinematic viscosity oils. One way to achieve higher kinematic viscosity base fluids is using polymers like polyisobutylene and synthetic base oils like Polyalphaolefins (PAO) as viscosity modifiers [5]. The use of high kinematic viscosity oils and polyisobutylene allows OGLs to better adhere to gears and prevent run-off during usage. More recently, new polymers like unique performance polymers (UPPs) have been found to be beneficial as viscosity modifiers and as base oils in other industrial gear oil applications (Ref. 5).

Type I OGLs

The evolution of open gear lubricants has produced two distinct types of OGLs—Type I and Type II. Type I, or grease type, OGLs were designed for mobile equipment typically found in mining and construction. Mobile equipment often has bidirectional operation, with frequent directional changes such as seen in hinge pins on backhoes, and in ring gears on excavators. An application issue is that they are often used in sub-ambient to sub-freezing point conditions. The type of greases used in these applications were often based on clay-thickened then more recently, aluminum complex thickeners (Ref. 6). Whatever thickener is used, the greases will contain chemically active additives for boundary lubrication protection, solid lubricants such as graphite, calcite, and molybdenum disulfide to help with surface separation under starved or parched lubrication. Diluent solvent may be required to aid application. Because Type I OGLs typically include a thickener, their consistency can be defined by an NLGI grade. The example Type I OGL specification can be seen in Table 1.

Type II OGLs

Type II OGLs or fluid OGLs are designed with stationary equipment in mind, such as sugar mills, cement kilns and grinding mills. These types of equipment operate in a single direction at slow operating velocities and warmer temperatures (50–80°C). The general requirements for an OGL in this application are high viscosities that support both boundary and fluid film lubrication. High kinematic viscosity fluids in these applications can enhance the OGL's adhesiveness to the gears, especially at elevated temperatures. Like Type I OGLs, several industry-wide specifications have been developed by the American Gear Manufacturers Association (AGMA) (Ref. 7) as well as different original equipment manufacturers. While every end use is different, Table 2 highlights a typical example of the specifications required from a Type II OGL.

Property	Test Method	Requirement
Solids Content	Calculation	No solids
Kinematic viscosity at 100°C, cSt	ASTM D445	850 – 950
Copper strip corrosion	ASTM D130, 4 hours, 100°C	1B
4-ball weld point, kgf	ASTM D2596	800 kgf weld
4-ball wear scar diameter, mm	ASTM D2266	0.6

Table 2—Example of performance specifications for a Type II OGL.

Property	Test Method	Requirement
Copper strip corrosion	ASTM D130, ASTM D4048;	
24 hours @ 100°C	2a max	
Rust protection	ASTM D1743	Pass
4-ball wear (without solvent)	ASTM D2266, wear scar diameter, 60 minutes @ 75°C	<0.70 mm
Weld point (without solvent)	ASTM D2596	>800 kgf
Load wear index (without solvent)		>120 kgf
Minimum base fluid kinematic viscosity Ambient temperature at point of lubricant application, °C (°F) -50–0 (-58–32) -20–40 (-4–104) 0–60 (32–140)	ASTM D445 /ISO 3104/ ASTM D2161	 680 cSt @ 40°C 2000 cSt @ 40°C 4000 cSt @ 40°C
Lubricant solid content (molybdenum disulfide, graphite, etc.)		6% minimum

Table 1—Example of a Type I open gear lubricant specifications.

End uses where Type II OGLs are utilized are opting more and more for solid-free fluids. The benefit to solid-free fluids is housekeeping and reduction of downtime. Equipment operators can easily inspect gears visually for damage which correlates to significant improvement in equipment reliability and a decrease in equipment shutdown.

Development of New OGL Technologies

Understanding the Importance of Base Oils and Polymers

Since OGLs rely heavily on base oil viscosity, the difference between viscosity improvers like, polyisobutylenes (PIB), polyalphaolefins (PAO) and unique performance polymers (UPP) needed to be better understood. We hypothesized that the UPP fluid would provide a lower coefficient of friction and better overall traction profile relative to the other base fluid types. Four base fluids were selected for a traction study and are highlighted in Table 3.

A base oil kinematic viscosity of 420 cSt at 40°C was targeted because of ease of testing. API Group II 600 N mineral oil was also selected as a baseline due to its inclusion in the PIB sample. Each of the oils was evaluated through MTM testing, which generated friction data at a range of slide:roll ratios. Each of the base fluids was loaded into the sample pot and was evaluated under the conditions shown in Table 4.

The temperature of 140°C was selected as a severe condition specifically to provide a worst case as a lubricant meshes between gears in field applications. Once each of the samples was loaded into the instrument, their traction coefficient was measured as the slide:roll ratio increased from 0–100 percent. Upon completion, traction coefficients were compared at a single slide:roll ratio and plotted in a bar graph (Figure 3).

	Mineral, weight	PIB, % weight	PAO, % weight	UPP 40, % weight
Group II 600 N	100	80		
Polyisobutylene		20		
PAO-40			100	
UPP 40				100
Kinematic viscosity at 40°C, cSt	117.6	454.4	428.7	420

Table 3—Base oils used for traction studies.

Test Parameter	MTM Test Condition
Load, N	72
Average contact pressure, GPa	1.25
Speed, r/min	2500
Temperature, °C	140

Table 4—MTM test conditions for base oil traction studies.

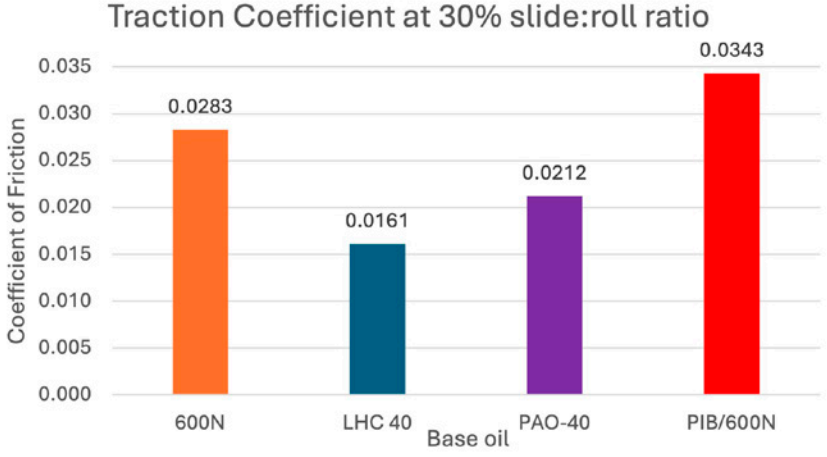


Figure 3—Traction coefficient comparison at 30 percent slide.

Based on the base oil screen in Figure 3, it appears that treatment of the Group II 600N oil with polyisobutylene at even low weight percent, had a deleterious effect on the coefficient of friction. Given the OGL markets almost ubiquitous use of PIB as a viscosity improver, it is of no surprise that PIB-based OGL are not top-tier performing base fluids in industrial applications from a thermal perspective. PIBs have higher internal friction because of branching, which causes higher churning loss under fluid film lubrication, hotter running temperatures and lower efficiency. Based on industry knowledge, it was expected that the coefficient of friction would decrease when the PAO was used since it has lower internal friction during usage. Unlike the PAO, it was unclear how the UPP would perform in this study. Based on the results in Figure 3, the UPP provided the lowest coefficient of friction compared to the PAO which suggests that OGLs may see a boost in performance, especially at elevated temperatures, when UPP is used as the base fluid.

Type I OGL Development and Field Trial

The results of the base fluid traction studies in the previous section led to an investigation on how the three different types of base fluids (mineral/PIB, PAO and UPP) would perform as a Type I, or grease type, OGL. The grease type OGLs prepared for this study were lithium greases with a kinematic base oil viscosity at 40°C of ~2,000 cSt. The base oil compositions can be seen in Table 5.

It was noted that the base oil composed of strictly UPP had a higher viscosity index (VI), which may translate into better thermal stability of the finished OGL compared to the others (Ref. 8). A high kinematic viscosity index indicated that the viscosity of the fluid will not change drastically as temperature increases (Ref. 7). Moving forward, the base oils from Table 5 were used for lithium greases and blended with and combination of additives and lubricating solids, targeting a NLGI grade 0, which can be seen in Table 6.

Component	Mineral, % weight	PAO, % weight	UPP, %weight
Brightstock 150	68		
PAO-100		87	
Polyisobutylene (Mn2000)	32	13	
UPP 100			80
UPP 2000			20
ASTM D445 Results			
Kinematic viscosity at 40°C, cSt	2074	2123	2145
Kinematic viscosity at 100°C, cSt	99.1	145.5	154.5
Viscosity index	121	172	179

Table 5—2000 cSt (at 40°C) base oil formulations.

Component	Mineral OGL, % weight	PAO OGL, % weight	UPP OGL, %weight
Lithium soap thickener	5	5	6
Polyisobutylene		87	
(Mn 2000)	25	10	
Brightstock (BS150)	53		
PAO 100		68	
UPP 100			62
UPP 1100			15
Additive Package	11	11	11
Solid lubricant	6	6	6

Table 6—Finished Type I OGL formulations.

The additive package in Table 6 includes additives for extreme pressure, antiwear, yellow metal corrosion and tackifier. Each of the finished OGLs were then evaluated for the properties required by the example specification from Table 1. The results from this testing can be seen in Table 7.

All three OGLs met the requirements of the defined specification, however, the UPP OGL had a smaller wear scar (ASTM D2266) compared to the other two OGLs.

To correlate the laboratory testing to industrial field applications, FZG testing was chosen as an additional metric of testing. FZG testing is used to evaluate the load carrying capacity of a fluid or grease via scuffing damage. Gear scuffing occurs when two teeth in a meshing gear set briefly adhere together and are then torn apart as the gears continue to rotate. This type of damage can lead to loss of contact geometry, leading to vibration, noise, and potential gear failure. As lubricant fluids thin under increased temperatures, load carrying additives become a necessity for gear protection.

In the FZG test, two specially designed gears are installed in a test chamber that will contain a specified amount of lubricant. These gears are manufactured to have very high sliding conditions, which creates an environment for scuffing to occur. The larger (wheel) test gear is connected to a shaft and motor, while a second smaller (pinion) test gear is connected to a parallel shaft containing a torsion coupling. A static load can be applied across the torsion coupling. These predefined loads are referred to as load stages and are the reported criteria once the scuffing failure limit has been exceeded. Most FZG tests run from load stage 1 to load stage 12 or failure, whichever occurs first. The extent of scuffing damage is assessed via visual inspection at the completion of each load stage (21,700 revolutions). The temperature at the end of each load stage is also observed.

Different FZG procedures can vary in motor speed, driver direction, gear width, gear temperature, and gear profile. Two common procedures are A/8.3/90 and A/2.8/50. A/8.3/90 typically follows the industry specifications ASTM D5182, CEC L-07 or ISO 14635 and uses A20 gears (20 mm thick), at 90°C starting temperature, rotating forward at a pitch line velocity of 8.3 m/s. A/2.8/50 has a lower velocity of 2.8 m/s and starting temperature of 50°C designed for testing gear greases, which follows ISO 14635-3 specification.

FZG A/2.8/50 (typical grease conditions) was executed examining the three samples (Table 5) over 12 load stages in the same testing stand. Using the ISO procedures, the gears are weighted after load stage 4. All three greases

Property	Test method	Requirement	Mineral OGL	PAO OGL	UPP OGL
Worked Penetration	D217	n/a	400–430	400–430	400–430
Copper strip corrosion	ASTM D4048	2A max	1B	1B	1B
Rust protection	ASTM D1743	Pass	Pass	Pass	Pass
4-ball wear, wear scar diameter, mm	ASTM D2266	0.70 max	0.70	0.68	0.45
4-ball weld point, kgf	ASTM D2596	800 pass	800 pass	800 pass	800 pass
LWI, kgf		120 min	149.3	139.3	143.6

Table 7—Performance Testing on Experimental OGLs.

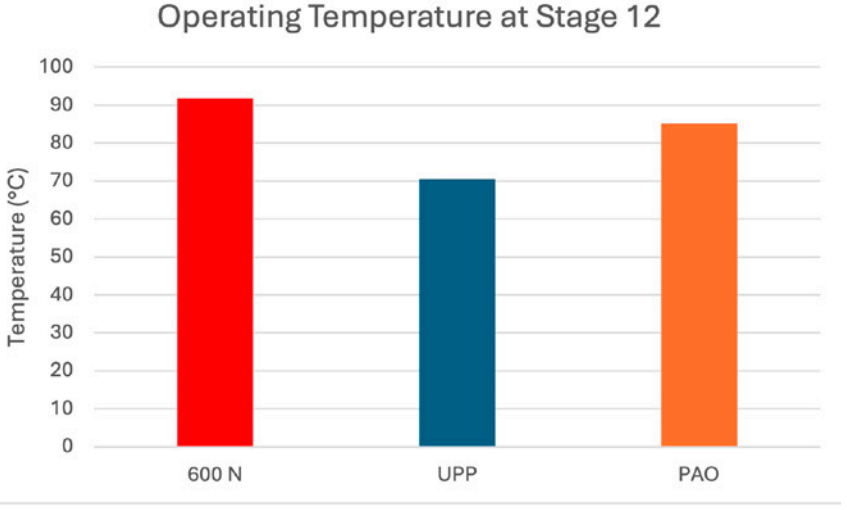


Figure 4—Temperature Reduction at FZG Stage 12.

passed the load stage 12. Operational temperatures and energy consumption were measured using the Mineral OGL as the baseline material. Figure 4 shows the operating temperature of each gear at the end of load stage 12.

Based on the results in Figure 4, it was concluded that the OGL made using the UPP base oil mixture operated 21°C cooler compared to the Mineral OGL. The UPP OGL also operated 15°C cooler compared to the PAO OGL. Thermal images of this testing were captured and can be seen in Figure 5.

The motor drives on the FZG stands were also capable of outputting the instantaneous power consumed by the motor every 10 seconds. This data can be plotted to form a power curve to illustrate power consumption over the course of the test. Integrating the power curve with respect to time provides the total energy consumed during a given period of time. In this case, trapezoidal integration was used to provide an approximation of the integral using the following equation:

$$\sum_{n=0}^{N-1} \frac{1}{2}(P_n + P_{n+1})\Delta t$$

where P is the instantaneous power consumed at the time step shown in the subscript. The energy values can then be compared between samples on a single given stand. This is best expressed as a percentage difference from a given baseline, as this type of analysis is relative to a given stand. The three OGL samples were run consecutively of the same stand and compared to the mineral oil (600N) baseline in Figure 6.

The results of the testing showed that the UPP based OGL consumed 20 percent less energy compared to the Mineral OGL and 5 percent less energy compared to the PAO OGL. In this comparison, UPP has demonstrated that it provides thermal and power consumption benefits compared to traditional OGL base oils.

The promising bench testing and mechanical testing allowed us to utilize UPP base OGL in a field trial to see how these grease type OGLs operated in real world, extreme, conditions. The field trial took place at a steel manufacturing facility in Germany. The grease type OGL was applied to the bearings of a casting ladle (Figure 7).

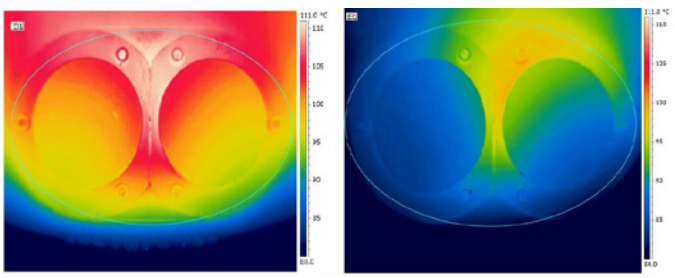


Figure 5—Thermal images of mineral OGL (left) and UPP OGL (right) at FZG Stage 12.

Figure 7—Image of a casting ladle at a steel manufacturer.

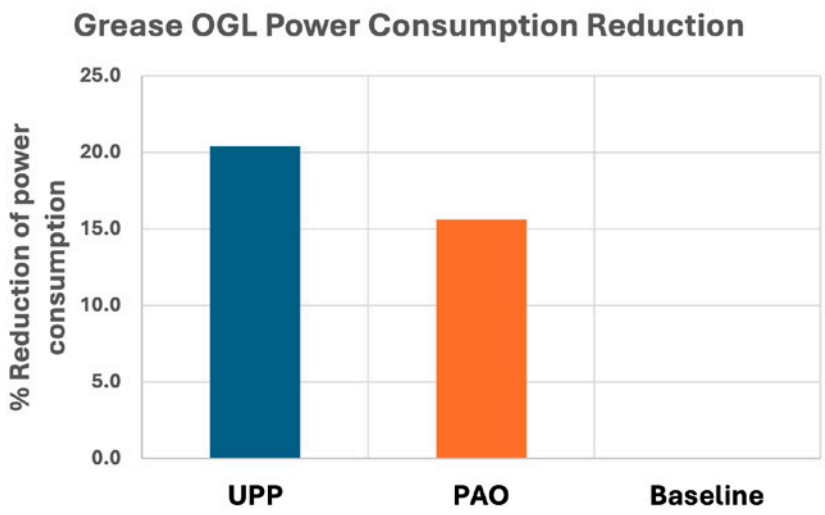


Figure 6—Power Consumption at Load Stage 12.

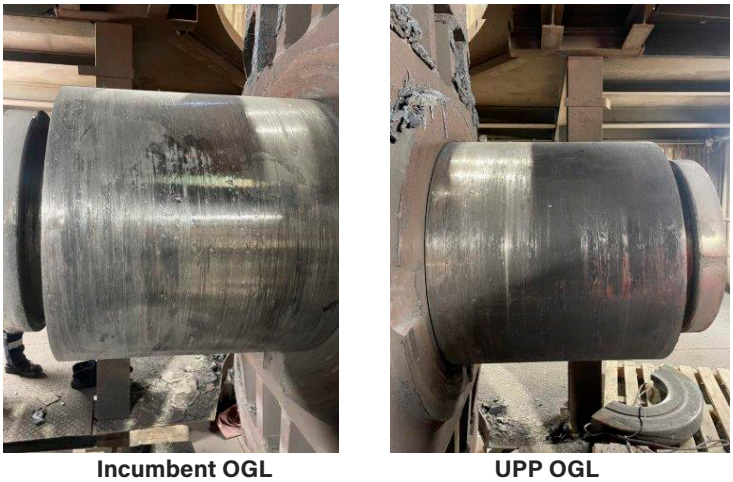
The basic composition of the field trial grease utilized a 7,000 cSt base oil composed of UPP and API Group II 600 N paraffinic oil. The composition and bench testing of this grease type OGL can be seen in Table 8.

The field trial conditions included: 6-month duration; 2000 MT of weight of the ladle; temperatures of 80 –200°C; 220 melts (900 tilts). Since the conditions were going to be very severe, a high viscosity base fluid was designed so that it was more likely to remain on the equipment instead of running off. The steel manufacturer applied the experimental OGL to one bearing of the casting ladle and the incumbent to the other bearing. After the six-month duration of the trial, the casting ladle was deconstructed and the bearings were evaluated. Images of these bearings can be seen in Figure 8.

The feedback that was received from the manufacturer was that the UPP OGL still remained on the bearing after the duration of the trial while the bearing that had the incumbent OGL was dry. This suggests that the high viscosity base oil that utilized UPP did remain where applied for the duration of the trial. It was also noted that there was minimal wear scarring on the bearing that used the UPP OGL. The bearing that used the incumbent OGL has substantial scarring.

Type I OGL Summary

Three grease type OGLs were formulated utilizing three types of base oils: mineral, PAO and UPP with an additive pack containing components for extreme pressure, antiwear and corrosion. The base oils that had kinematic viscosities around 2000 cSt at 40°C but had different kinematic viscosity index results. Because the UPP OGL had the highest kinematic viscosity index, it was thought that it would have beneficial properties at elevated temperatures compared to the other two OGLs. It appeared that the UPP based OGL did provide some additional antiwear performance. The three OGLs were then evaluated in the FZG A/2.8/50 which could be more easily correlated to real life applications in the field. This



Incumbent OGL **UPP OGL**

Figure 8—Images of bearings after six-month field trial.

Component	% Weight
Lithium complex/7000 cSt UPP base oil	84
Additive package	10
Solid lubricants	6
wt% Soap	7 – 9
Performance Results	
Penetration, work 60 (ASTM D1403)	357
Dropping point, °C (ASTM D2265)	250
4-ball weld point, kg (ASTM D2596)	>800
4-ball wear scar, mm (ASTM D2266)	0.45
Corrosion protection	Pass

Table 8—Composition and bench test results of field trial grease OGL.

testing illustrated that the UPP OGL did provide a thermal benefit; in that it allowed for the test rig to operate at a temperature 21°C cooler compared to the mineral OGL. The FZG testing also demonstrated that the UPP OGL consumed 20 percent less energy when compared to the Mineral OGL on the same stand under the same operating conditions. The benefits of UPPs have also translated to top tier performance in the field. This has been demonstrated by the excellent load carry and antiwear capabilities of the UPP OGL used in the steel manufacturing field trial.

Type II OGL Development

Next in our OGL study, the effects of base oils in higher kinematic viscosity fluid type OGL were tested. We started with grease types and now wanted to validate that we saw similar effects in fluid types and determine if the thickener system contributed anything significant to the performance advantage presented in the UPP sample or the performance benefits were primarily attributed to the UPP. The Type II OGL fluids that were developed were blends of oils and kinematic viscosity modifiers that were then treated with the same. The formulations for these OGLs can be seen in Table 9.

It is important to note that the PAO OGL required a heavy amount of PIB to meet the required viscosity requirements. Although PAOs have been shown to provide thermal stability, they do not offer high viscosity options like the UPPs. Since there are a wide range of UPP viscosity options, there is much more flexibility to formulations.

The individual requirements for this study are captured in Table 10 and are like the grease type requirements presented in the previous section Table 2. Load carrying was one stage lower. Based on the nature of these materials being fluid type, the additive pack is similar to additive package used in the grease study but not identical. Each of the Type II OGL fluids were evaluated for the properties seen in Table 10.

Like the Type I OGLs, UPP again seems to have played a role in the reduction of the wear scar compared to the mineral oil OGL. It was also observed that the Mineral OGL does not perform as well as the PAO and UPP OGL in the load carry. These results suggest that base oil modifications and identity to a fluid type OGL may influence overall performance. An additional observation that was made was the decrease in pour point of the UPP OGL compared to the other two fluids, which suggests that the UPP OGL may be easier to handle.

Components	Mineral OGL, % weight	PAO OGL, % weight	UPP OGL, % weight
Polyisobutylene (Mn2000)	68	65	
Brightstock (BS150)	24		
PAO-100		27	
UPP 2000			78
Group II 600 N			14
Additive package	8	8	8

Table 9—Type II fluid OGL formulations.

Property	Test method	Target	Mineral OGL	PAO OGL	UPP OGL
Kinematic viscosity at 40°C	ASTM D445	Report	30,400	20,000	16,500
Kinematic viscosity at 100°C	ASTM D445	850-950	877	861	926
Viscosity index	ASTM D2270	Report	195	228	258
Pour point, °C	ASTM D5950	Report	3	6	-9
Rust protection	ASTM D1743	Pass	Pass	Pass	Pass
Copper strip corrosion	ASTM D130, 100°C, 3 h	1B	1B	1B	1B
4-ball weld point, kgf	ASTM D2596	800	620	800	800
LWI, kgf		Report	128.8	144.4	145.2
4-ball wear scar diameter, mm	ASTM D2266	0.6	0.73	0.50	0.46

Table 10—Performance properties of Type II OGLs.

In similar fashion to the Type I OGL studies, FZG testing was also conducted on the Type II fluid OGLs on the same test stand. The test conditions used were specifically for a fluid type—A/8.3/90. All fluids completed 12 load stages without scuffing. The end of test operational temperatures were compared, using the Mineral OGL as the baseline. The results can be seen in Figure 9.

The UPP OGL completed load stage 12 at a temperature 15°C cooler compared to the Mineral and the PAO OGLs. The PAO and Mineral OGL seemed to perform identically which is likely due to the similar amounts of PIB needed to achieve their desired viscosities. While this test was being conducted, thermal images were again taken so that the temperature differences could be visualized in Figure 10.

The color profile of these thermal images is different than the images of the Type I grease OGLs in Figure 5 because a different imaging software was employed. The images show that both the Mineral OGL and PAO OGL run at an elevated temperature in comparison to the gear box running in the UPP fluid OGL. The energy consumption data collected from this testing correlated to the thermal data as well.

Energy consumption data calculation was executed as indicated in the previous section. The results from the FZG testing found that the UPP OGL consumed 13 percent less energy compared to the Mineral OGL and 11 percent less energy compared to the PAO (Figure 11).

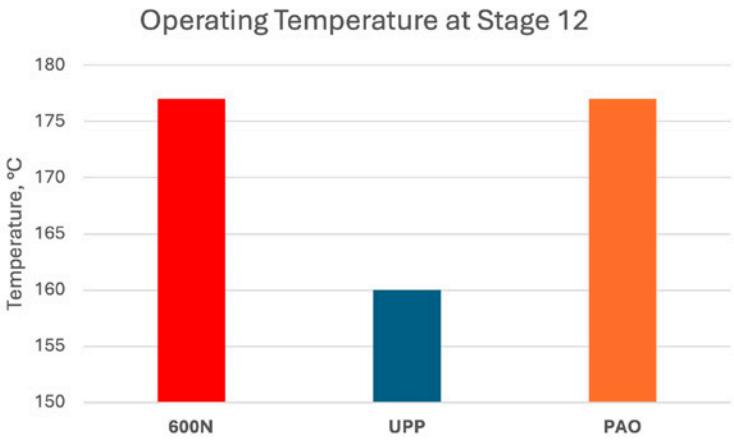


Figure 9—FZG temperature reduction at load stage 12.

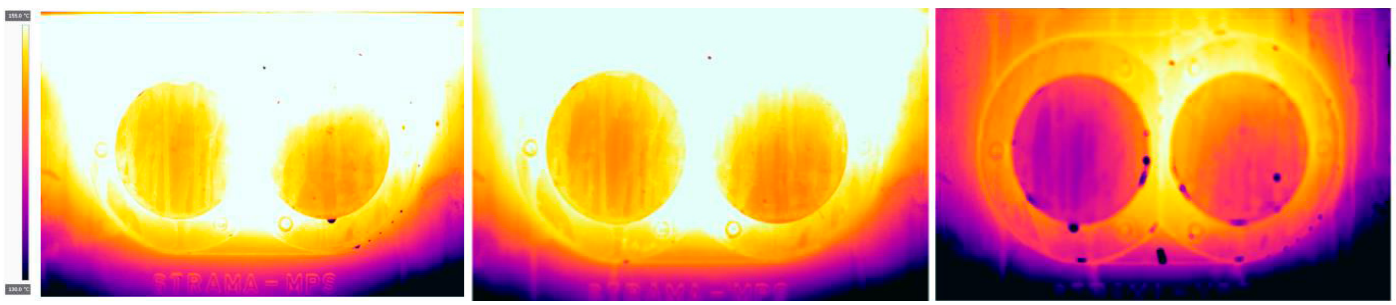


Figure 10—Thermal images of mineral OGL (left), PAO OGL (middle), and UPP OGL (right) at FZG load stage 12.

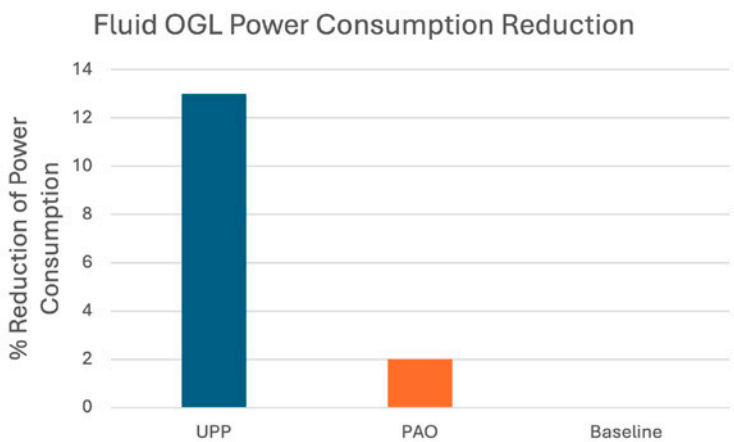


Figure 11—Power consumption reduction at load stage 12.

Similar to the Type I OGL development, we wanted to translate the Type II development in the field applications. The first trial occurred at a sugar mill in North America where the OGL was designed for the open gear as well as journal bearings. The fluid OGL was applied to journal bearings (decided by the refinery) for the duration of one season of sugar cane refining. The conditions an OGL faces in sugar mill are extremely harsh and include: high temperature, high humidity, juice and water contamination, high presence of dry and wet bagasse as well as constant power washing. The fluid formulation that was introduced into this field trial can be seen in Table 11.

During the field trial, two main parameters were monitored: operating temperature and lubricant consumption. The UPP OGL was evaluated and compared with an incumbent OGL operating on a second mill in the same season and for the same duration of time. At the end of the refining season, the sugar mill reported its overall findings which can be seen in Table 12.

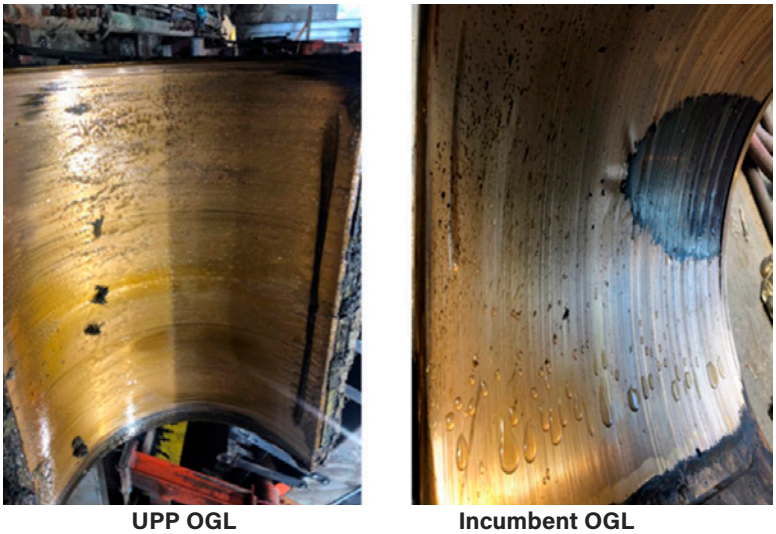
The sugar refinery communicated that the UPP OGL allowed them to reduce the lubrication interval which decreased lubricant consumption by 35 percent. They also reported that the mill with the UPP OGL operated 10°F cooler in comparison to the mill with the incumbent OGL. Lastly, they reported that upon inspection of the journal bearings at the end of the season; the bearing that was lubricated with the UPP OGL could be used for another sugar season. The pictures of the journal bearings at the conclusion of the trial can be seen in Figure 12.

Component	% by weight
UPP/base oil blend	94
Performance additives	6
Performance Properties	
Kinematic Viscosity @ 40°C	20,719
Viscosity Index	271
4-ball weld point, kgf ASTM D2596	620
4-ball wear scar, mm ASTM D2266	0.40

Table 11—Type II UPP OGL formulation and performance.

	UPP OGL	Incumbent OGL
Average operating temperature, °F	74.1 (23.4°C)	84.2 (29.0°C)
Set lubrication interval at end of trial	18 minutes	10 minutes
Bearing appearance at end of trial	Minimal wear scarring	Catastrophic wear damage

Table 12—Results of sugar mill trial.



UPP OGL **Incumbent OGL**

Figure 12—Appearance of journal bearings at the end of trial.

After the successful trial at the sugar refinery, an opportunity to trial at a ball mill presented itself. The ball mills in need of a fluid OGL were located near a copper mine in Peru. The UPP formulation required higher load carry capabilities, so we selected the UPP formulation seen in Table 9. This UPP fluid OGL would be evaluated on two different ball mills. The details of the ball mills can be seen in Table 13.

Unlike the sugar mill trial, both mills were lubricated with the incumbent OGL and temperature and lubrication consumption were measured. The UPP OGL was then cycled into both mills and the same parameters were monitored. Both mills' operating temperatures were reduced by 5–6°C. The temperature reduction in ball mill 09 can be seen in Figure 13.

This trial is still ongoing, however, the last reports from the mine site have reported that they have reduced the lubrication interval on both mills from 20 minutes to 25 minutes, while maintaining the reduction in operating temperature. The mine site has also reported that they have seen a 9.4 percent reduction in energy consumption on ball mill 09 and a 16.7 percent reduction in energy consumption in ball mill 10. The reduction in energy was based on the energy consumption while the incumbent OGL was in use.

Type II OGL Summary

The Type II OGLs, or fluid OGLs, were formulated using the same additive system across these samples so that base fluids could be compared directly. Both synthetic OGLs (PAO and UPP) were able to meet the specifications that were set in Table 10, compared to the mineral that struggled to meet the load carrying and wear specifications. It was also observed that the pour point of the UPP OGL was significantly lower which would lead to easier handling and application in the field in colder climates and end uses. Like the grease type OGLs, comparatively, the fluid OGLs performed similarly when in FZG testing. When UPP is used as a base oil, the corresponding OGL operates at

	Ball Mill 09	Ball Mill 10
Brand	Norberg	Citic Heavy
Size (diameter x length, m)	4.27 x 12	4.27 x 12
Mill speed (r/min)	14.6	15.7
Type of lubrication system	Double line	progressive
# of lubrication points	7	6

Table 13—Ball mill characteristics.

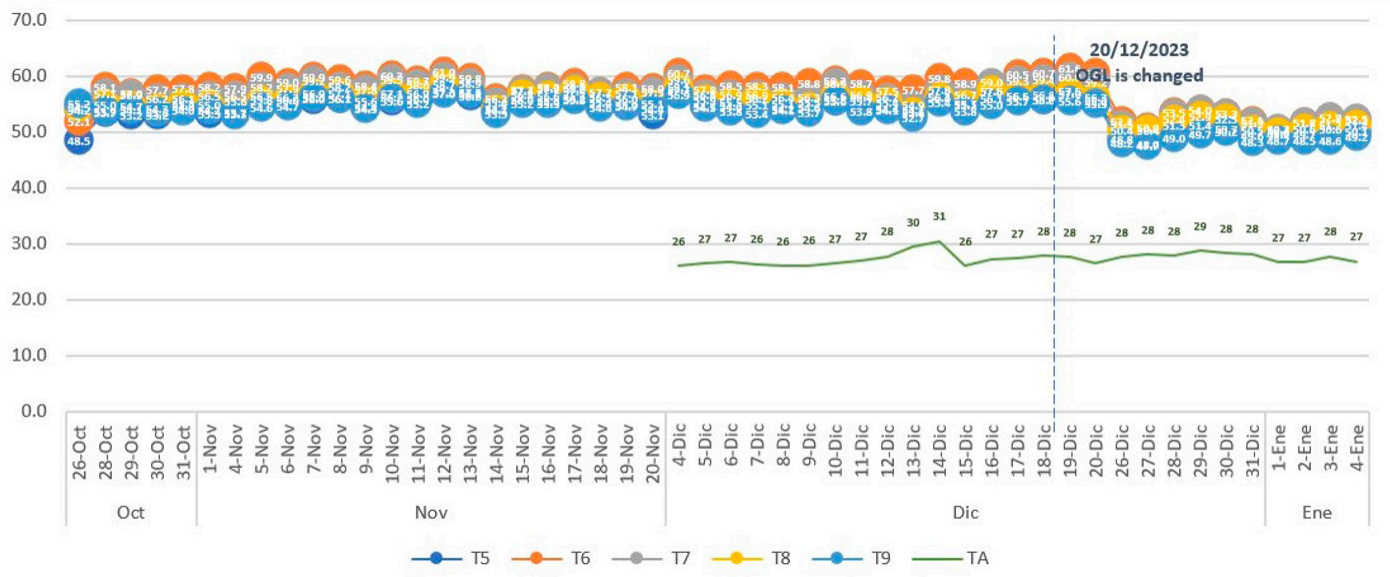


Figure 13—Temperature monitoring of ball mill 09 after introduction of UPP OGL.

a much lower temperature and consumes less energy compared to PAO and Mineral OGLs. Field trials in both a sugar mill and two ball mills have further demonstrated the outstanding performance benefits from UPP based OGLs. Reduction of lubricant use, reduction in operating temperatures, reduction in energy consumption and extended tool life are a result of UPP polymers and can be a substantial cost savings to the refineries.

Conclusion

In the development of new OGLs, both Type I and Type II, it was determined that base fluid selection was critical to performance. Early traction studies demonstrated that synthetic fluids, especially unique performance polymers such as UPP, decrease the coefficient of friction compared to mineral oil/polyisobutylene (PIB) blends, especially at elevated temperatures. This trend was then further observed and confirmed in both grease and fluid OGL through FZG evaluations. Based on this testing, it was believed that UPP based OGL, grease or fluid, would allow the end user to consume less OGL, operate at lower temperatures and potentially extend the life of the gears in their equipment. This hypothesis was further proven by the successful field trials at a steel manufacturer, a sugar mill and copper refining ball mills.

PTE

Dr. Jennifer Clark has been a technology development manager for Lubrizol for 13 years. Since 2019 she worked as a technology development manager for the industrial grease team, where she focuses on the development of new open gear lubricant technology, grease thickener development and additive formulation.

Dr. Robert Dura, with a Ph.D. in organic chemistry from Ohio State, has been with Lubrizol since 2014. He's held key roles, including director of grease and metalworking fluid development. Previously with Boehringer Ingelheim, he recently earned CLGS certification, joining an elite group of grease specialists.

Roberto Saruls, a chemical engineer from UERJ, has been a product manager at Lubrizol for 8 years, focusing on the Latin American industrial segment. With 38 years of prior experience in R&D, field engineering, and marketing, he also holds a master's in industrial processes and an MBA in marketing.

References

1. Fish, G., Clark, J., McCune, D., Hsu, C., "Technology for Enhanced Girth Gear Greases," NLGI India 26th Annual Meeting, Kolkota, February 2024.
2. "Lubrication of enclosed and open Gearing" AGMA Lubrication standard 250.01 (1946) reproduced in the pre-amble to AGMA 9005-F16 (2021): *www.agma.org*
3. de Vaal, P.L., "Open-Gear Lubrication: Meeting Industrial Requirements using Laboratory Techniques" *Tribotest Journal*, 1998, Vol. 5, p. 79.
4. Samman, N., and Lau, S.N., "Grease Based Open Gear Lubricants: Multi-Service Products Development and Evaluation" *NLGI Spokesman*, 1998, Vol. 62, No. 9, p 34.
5. Clark, J., Dura, R.D., Fish, G., Nazario, C., Jacobs, M., and Zhao, H. "Enabling Technologies for Enhanced Open Gear Greases and Fluids", Paper #2223 NLGI 89th Annual Meeting, Toronto Ontario, Canada, June 2022.
6. Lorimor, J.J., and Hsu, C., "Understanding Open Gear Lubricants: Product Design Considerations" Presented at the NLGI 79th Annual Meeting Palm Beach, FL June 9–12, 2012.
7. ANSI/AGMA 9005-F16 (2016) American National Standard Industrial Gear Lubrication.
8. ASTM D2270-10 (2016) Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40°C and 100°C ASTM International, West Conshohocken, PA.

ABB

Appoints Susana Gonzalez as chief sales officer, machine automation division, at B&R

ABB has appointed Susana Gonzalez as chief sales officer, machine automation division, B&R (A Member of the ABB Group), effective February 2025. Gonzalez, who has over 25 years of global experience in industrial automation and manufacturing, will lead B&R's global sales organization and serve as a member of the division management team. She succeeds Luca Galluzzi who held the position for the past five years.

Gonzalez has extensive global expertise in developing and implementing strategies to drive sales growth and enhance customer experience. She joins B&R from Rockwell Automation, where she led sales for the EMEA region. Gonzalez's diverse background includes roles in customer support, product management, and sales across the United States, Asia, Europe, the Middle East, and Africa.

"Susana's extensive international experience and strategic approach make her an excellent fit for this role," said Joerg Theis, president of ABB's machine automation division. "Her leadership will strengthen our customer focus and ensure we continue to deliver innovative solutions that address the evolving needs of our customers while maintaining our commitment to quality and performance."

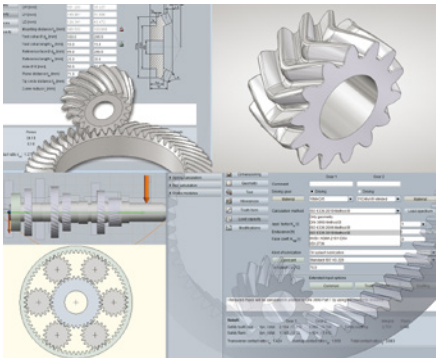
"I am excited to join B&R at this pivotal moment in the division's history," said Gonzalez. "B&R has a strong tradition of providing exceptional support to customers and adapting to their evolving needs. By leveraging customer insights, we will drive growth and innovation, improve our sales processes, and work closely with our Research and Development team to deliver solutions that meet and exceed customer expectations."

Gonzalez holds a degree in business administration from Asturias Business School and an MBA from San Francisco State University.

`br-automation.com`

GWJ

Introduces 2025 seminar schedule



GWJ Technology is starting a new seminar schedule in 2025. This year, GWJ is once again offering a wide range of different seminars that can be booked as online seminars or, if desired, as traditional face-to-face events. The online seminars are designed to be interactive and provide a comprehensive insight into the respective topic. Practical exercises deepen the content. Online seminars take place over two or three days and last two hours each.

The range of seminars includes a variety of topics that provide both theoretical knowledge and practical skills, such as "Basics, Design and Optimization of Cylindrical Gears". This intensive seminar covers basic theoretical knowledge of cylindrical gears. It gives an overview of key terms and definitions. Participants will also learn tips and tricks for designing and optimizing cylindrical gears—always practical and up to date. Other topics include bevel gears, bolts, shaft-hub connections, shafts and bearings, or *System Manager*.

The workshops are designed for both new and experienced engineers, designers and technicians who want to refresh their basic knowledge. In all seminars the GWJ products *eAssistant, TBK 2014, SystemManager* and *GearEngineer* will be used. No previous knowledge of these programs is required.

In addition to the scheduled dates, GWJ also offers company-specific seminars and workshops in Braunschweig, online or on-site. The content and dates are agreed in advance—a tailor-made seminar to suit the needs of the participants. All seminars are offered in English or German language.

`gwj.de`

WEG

Expands automation factory in Mexico

WEG recently inaugurated the expansion of its automation products factory in Atotonilco de Tula, Mexico. With approximately 4,900 sq. m of built area, the structure represents the expansion of the existing factory, which previously operated in a shared building and now has a dedicated space, ensuring greater efficiency and production capacity to meet the growing demand of the local market.

The factory has consolidated itself as a center of competence and expertise, housing production areas, engineering, panel projects, and a training space for customers and employees.

The unit features high technology, including collaborative robots and vision systems, which ensure greater efficiency and accuracy in the production processes. With a robust capacity for manufacturing electrical panels, the factory follows the WEG Manufacturing System to optimize resources and ensure quality.

Additionally, the structure offers a complete space for training, a showroom for product displays, and an electric vehicle charging station, reinforcing WEG's commitment to innovation and sustainability.

Committed to sustainability, the plant is equipped with a solar energy generation system capable of meeting a significant portion of its energy demand. The generated energy is monitored by proprietary technologies such as the WEGScan and WEG Energy systems, ensuring efficient resource management and helping optimize consumption.

With this expansion, WEG reinforces its commitment to innovation, excellence, and the strengthening of its presence in the industrial sector.

weg.net

DAVID BROWN SANTASALO

Expands carbon footprint products reporting to girth gears

As a part of David Brown Santasalo's (DB Santasalo) ongoing commitment to the Science Based Targets initiative (SBTi), the global gear manufacturer introduced "Carbon Footprint of Products (CFP) Cradle to Gate CO_2 equivalent" reporting for all their mining products in early 2022. Since that time, they have introduced the CFP Cradle to Gate CO_2eq for their segmented girth gear range of products.

In 2021, David Brown Santasalo was one of the first gearbox manufacturers to commit to the Science Based Targets initiative (SBTi). Their SBTi commitments include reducing absolute scope 1 and 2 GHG emissions by 53.9 percent by 2032 from a 2021 base year. Additionally, 67 percent of DB Santasalo suppliers by emissions covering purchased goods and services will have science-based targets by 2027. DB Santasalo further commits that 70 percent of its customers by emissions covering use of sold products, will have science based targets by 2027. Their targets were submitted for official evaluation by the SBTi Validation Team and following a rigorous review against the SBTi science-based criteria, DB Santasalo's targets were officially approved.

The initial project calculated the Carbon Footprint of Products (Cradle to Gate CO_2eq) of all their mining products, manufactured in the purpose-built, energy efficient factory in Jyväskylä, Finland. This project has enabled DB Santasalo to develop a better understanding of the Scope 3 inventory of their value chain, in line with their SBTi commitments.

In order to build on this knowledge, DBS engineering specialists identified a need to screen the greenhouse gas emissions associated with their multisegmented ring gears and develop a simple tool for emission calculation. In this way DBS engineers could evaluate the impact of varying supplier and distribution scenarios on greenhouse gas emissions.

This study, undertaken in accordance with ISO14067, focused on three DB Santasalo girth gear products, comprising one spring mounted and two flange mounted products. The system boundary was defined as cradle-to-gate + distribution, ensuring that the emissions profile was clearly understood across the life-cycle phases including raw material supply, transport, manufacturing processes and onward distribution to the customer. The manufacturing phases included the subcontracting foundry and heat treatment phases, together with the DBS machining, painting and assembly. Use phase and end of life phase were excluded from the study.

The carbon footprint calculation tool analyzed all inputs and outputs including energy consumption in manufacturing, transport, packaging and ancillary materials, water consumption and waste generated. The results were presented as kg CO_2eq/per 1 kg of product, per life cycle phase, to understand the varying impacts on emissions of each phase. The kg CO_2eq was then multiplied by the product mass to provide the total carbon footprint of each of the products once manufactured and delivered to the customer.

It was identified that the greatest proportion of emissions are associated with the foundry production processes due to the energy intensive nature of the industry. The second largest element of climate impact was the raw material supply. The transport element of both raw materials to manufacturing and that of the finished product to customer was limited. Emissions associated with DBS machining and assembly were also minimal, primarily because of the Jyväsklyä facility benefiting from hydro-electric power and district heating.

dbsantasalo.com

BORGWARNER

Expands energy vehicle motor business

BorgWarner continues to expand its new energy vehicle motor business and has recently secured four new projects with three major Chinese domestic brands. The projects include the supply of 400V high-voltage hairpin (HVH) motors to a

prominent Chinese new energy vehicle supplier for their 200kW hybrid rear-drive platform, with production planned to commence in August 2025. BorgWarner will also provide motors for a top Chinese domestic OEM's 150kW pure electric platform, scheduled for mass production in March 2026. Additionally, the company will supply electric motors for the next-generation vehicles of another major Chinese domestic OEM, covering both range-extended and plug-in hybrid models, with production anticipated to begin in August and October 2025.

"We are pleased to extend our success in China with several new electric motor business wins for a variety of hybrid and electric applications," said Dr. Stefan Demmerle, president and general manager of BorgWarner PowerDrive Systems. "We are dedicated to continuously innovating our technology and improving our manufacturing processes to deliver high-quality products and services to meet the evolving needs of new energy vehicle customers."

To meet the growing demand in China's new energy vehicle market, BorgWarner has introduced a new eMotor technology called Ultra-Short High-Voltage Hairpin (S-HVH). This technology utilizes an optimized manufacturing process to produce very short end turn lengths which reduce overall length of the motor. The S-HVH e-Motor technology reduces end size by over 5mm compared to traditional HVH winding, while also lowering axial volume, increasing power density, and reducing copper usage for improved efficiency and cost savings. The technology is compatible with existing production lines, enabling easy factory upgrades. Versatile and adaptable, it supports a wide range of new energy vehicle models and is suitable for both 400V and 800V platforms.

borgwarner.com

TIMKEN

Announces retirement of Christopher Coughlin

The Timken Company recently announced that Christopher A. Coughlin, executive vice president and president, industrial motion, will retire at the end of the year after 41 years with the company.

"Chris has been an invaluable part of Timken's leadership team, demonstrating exemplary stewardship and a deep commitment to the company's mission for more than four decades," said John M. Timken Jr., chairman of the Timken Board of Directors. "On behalf of the board, I thank Chris for his strong leadership and wish him well in retirement."

"Chris has played a key role in the performance improvement of the company over the years," said Tarak Mehta, president and chief executive officer. "This includes diversifying the company's business through organic growth initiatives, product innovation and strategic M&A. In his most recent position, Chris expanded the company's industrial motion offerings to better serve our customers' evolving needs. We are grateful to Chris for his many contributions."

Prior to his current role, Coughlin led the engineered bearings business. He is credited with developing Timken's global manufacturing footprint and extensive distribution network, delivering industry-leading quality and customer service levels and running Timken operations with greater efficiency to drive performance.

"My time at Timken has been filled with memorable experiences and opportunities to work with many great people around the world," Coughlin said. "I appreciate the Timken team and the partnerships we built with our customers, and I'm optimistic about the future of the company."

A search process is underway to identify Coughlin's successor and ensure a seamless transition.

timken.com

ATLANTIC BEARING SERVICES

Sponsors U.S. Caribbean Business Conference 2025

Atlantic Bearing Services will take part in the U.S. Caribbean Business Conference 2025 as a bronze sponsor, reinforcing its growth and commitment to strengthening business relationships in the Caribbean. As one of the leading engineering companies participating, ABS joins top companies from various industries in a key event to explore new opportunities in the region.

This conference, organized by the South Florida District Export Council in collaboration with the U.S. Commercial Service, will bring together more than 500 business leaders, industry experts, and government representatives to share their knowledge and insights on the future of trade in the area.

ABS continues to invest in innovation and the development of engineering solutions for heavy industry and the renewable energy sector through ABS Wind, supporting spaces for dialogue and collaboration that drive growth and competitiveness on a global scale.

The U.S. Caribbean Business Conference 2025 takes place at the Hilton Miami Blue Lagoon from May 13–14, 2025.

atlantic-bearing.com

May 12–15

Automate 2025

Between intimate workshops with industry giants, keynotes, networking events, innovation competitions and live demonstrations, Automate (Detroit) offers comprehensive automation education and cutting-edge robotics, vision, AI, motion control and other technologies. Keynote sessions highlight how these technologies solve real-world challenges while theater sessions cover important topics such as how robotics and automation are transforming the economy; innovative strategies for jumpstarting an automation strategy, or how companies can cultivate talents in the workforce. This year will again feature presentations from the finalists of the Automate Startup Competition.

powertransmission.com/events/941-automate-2025

May 13–14

CTI Symposium USA 2025

CO_2 reduction is critical for automotive drivetrain. Here the battery electric drive using renewable energy is the focus. What can we do to increase efficiency and reliability, reduce cost and at the same time reduce upstream CO_2? At CTI Symposium USA 2025 (Novi, MI) the automotive industry discusses the challenges it faces and promising strategies. The latest solutions in the fields of electric drives, power electronics, battery systems, e-Machines as well as the manufacturing of these components and supply chain improvements are presented. In 2025, executives and experts of OEMs, suppliers and laboratories will discuss in various panels the actual challenges the industry is facing including how to manage the e-Mobility transition 2.0, the impact of politics and consumer adoption.

powertransmission.com/events/942-cti-symposium-usa-2025

May 19–22

Cleanpower 2025

Cleanpower 2025 (Phoenix) grows businesses by gathering key decision makers and stakeholders across the wind, solar, storage, hydrogen, and transmission industries for discussion, deal making, networking and a whole lot of fun. The trade show not only brings together the different technologies that make up the renewables mix; onshore wind, offshore wind, solar, storage, and transmission but also the different segments within the industries; manufacturers, construction firms, owner operators, utilities, financial firms, corporate buyers and more. Cleanpower will feature the latest products, services and technologies coming to the renewable energy industry.

powertransmission.com/events/977-cleanpower-2025

June 2–5

Reliable Plant 2025

This three-day event (Schaumburg, IL) offers attendees learning sessions and case studies on the latest industrial lubrication and oil analysis technologies. The comprehensive conference schedule covers every facet of the machinery lubrication industry and includes workshops on topics such as employee performance, lubrication fundamentals, condition-based maintenance and planning. Reliable Plant attendees come to the conference to connect with suppliers and service providers who can help them achieve bottom-line results in maintenance, reliability, and operations. From technicians and planners to management and leadership, you will be able to meet and influence entire buying teams at Reliable Plant. The event is colocated with Machinery Lubrication.

powertransmission.com/events/reliable-plant-2025

June 15–18

PowderMet2025

PowderMet2025 (Phoenix) is dedicated to metal powder and particulate materials-based processes including press and sinter, metal additive manufacturing, metal injection molding and more. The show provides an energetic forum to showcase PM, metal AM, and MIM equipment, powders, products, and services. MPM2025, colocated with PowderMet 2025, is a technical conference and exhibition dedicated to metal additive manufacturing. Attendees can dive deep into the latest advancements in the field through insightful technical presentations and explore exhibits showcasing additive manufacturing technologies. Sessions include topics on material development, standards, metal density, and more.

powertransmission.com/events/powdermet-2025

AD INDEX

CALL FOR PAPERS!

Are you sitting on an idea for a technical paper but wondering where to present it? Do you have one already written, sitting on your desk, gathering machine dust?
How about *Power Transmission Engineering*? We are always looking for gearing- and power transmission component-relevant technical papers for publication in the magazine and in its digital version. Having your work appear in *Power Transmission Engineering* guarantees you an audience of the most experienced and discriminating industry players. You say your work has not been peer-reviewed? Not a problem, as we are lucky — and thankful — to have on-hand some of the most experienced and brilliant minds in the industry — our technical editors. So if your work "passes muster" and is published, you'll know you were reviewed by the best — and most demanding.
Chances are you'll be creating the paper under the auspices of the company for whom you work or own, or for one of the various industry-relevant associations. That means they as well will bask in the reflected glory that accrues with publication in *Power Transmission Engineering*.
For publication guidelines and more information, please contact Randy Stott at *stott@agma.org*

PTE™

FREE SUBSCRIPTION

☐ Renew my subscription ☐ NEW subscriber

25PTEALL

☐ **YES** I want to receive/continue to receive ***PTE*** ☐ NO

Name _____

Job Title _____

Company Name _____

Company Address _____

City _____

State _____

Zip Code _____

Signature: _____
(required)

Date: _____

Please send
☐ PRINT Version
☐ DIGITAL Version (E-mail required)
E-MAIL: _____
☐ BOTH Print and Digital
*You can OPT OUT at any time.

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

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

What is your company's principal product or service?

_____

Your mailing label on the cover looks like this:

X/Y - means you have recieved a complimentary copy. Please complete this form to continue receiving your FREE copy of PTE.

Q14 (shown above) - means you have 14 issues remaining in your subscription (a NEW subscription has 16 issues).

Q1 - means you have 1 remaining issue before your PTE subscription expires. Please complete this form to renew.

MAIL to: 1001 N. Fairfax St, Suite 500, Alexandria, VA 22314 USA | SCAN to: *subscribe@powertransmission.com* | FAX to: 1.847.437.6618

From Anime to Engineering

Gundam's enduring cultural legacy

Aaron Fagan, Senior Editor

For anime lovers, Gundam is not just a Japanese television series; it's a cultural phenomenon. Since its debut in 1979, Mobile Suit Gundam has shaped how we think about the future, technology, and humanity's place in the cosmos. Set in the Universal Century, a fictional era where humans live in space, Gundam's depiction of "mobile suits" and the struggles of war has resonated with generations of fans across the globe. But the impact of Gundam goes far beyond entertainment—it's a symbol of human ambition, creativity, and the drive to reach beyond our current limitations.

One of the most profound examples of this vision came to life in December 2020, when the RX-78F00 Gundam—a life-sized, moving statue—was unveiled in Yokohama to mark the 40th anniversary of Mobile Suit Gundam. Standing 60 feet tall, this Gundam wasn't just a replica—it was a technological marvel, capable of moving its head, arms, and even kneeling. The exhibit, which ran from December 2020 to March 2024, was extended twice due to overwhelming demand, with over 1.5 million visitors witnessing its stunning performances at the Gundam Factory Yokohama.

At the heart of the RX-78F00 Gundam's movement system was Sumitomo Drive Technologies' Paramax gearbox, a state-of-the-art industrial drive solution enabling smooth, precise, and safe articulation. Paramax gearboxes are known for their robust design, high-load capacity, and reliability in industrial applications. Featuring a 25-degree pressure angle for enhanced dedendum strength, optimized cooling efficiency, and low-noise operation, the Paramax gearbox played a crucial role in making the Gundam come to life. These features ensured stability and durability, embodying the engineering marvels that push mechanical limits.

The RX-78F00 Gundam was dismantled following its successful run, but it won't disappear from the spotlight. Instead, it's heading to the Gundam Next Future Pavilion at Expo 2025 in Osaka—where it will take on a powerful new form as statue. The exhibit—running from April 13 to October 13 of this year—will invite visitors into a world where life in space is commonplace, with futuristic concepts such as orbital elevators and coexisting with mobile suits depicted through immersive experiences.

Unlike previous life-size Gundams, the statue at Expo 2025 will not stand upright. Instead, it will kneel, with its hand outstretched toward the heavens. After sundown, beacons of light will shine from behind the statue, creating a dramatic effect that emphasizes its towering form—not as a weapon of war, but as a vision of the future we can all build together. From Yokohama to Osaka, as humanity continues to reach for the stars, Gundam reminds us that the impossible is always within our grasp, waiting to be realized.

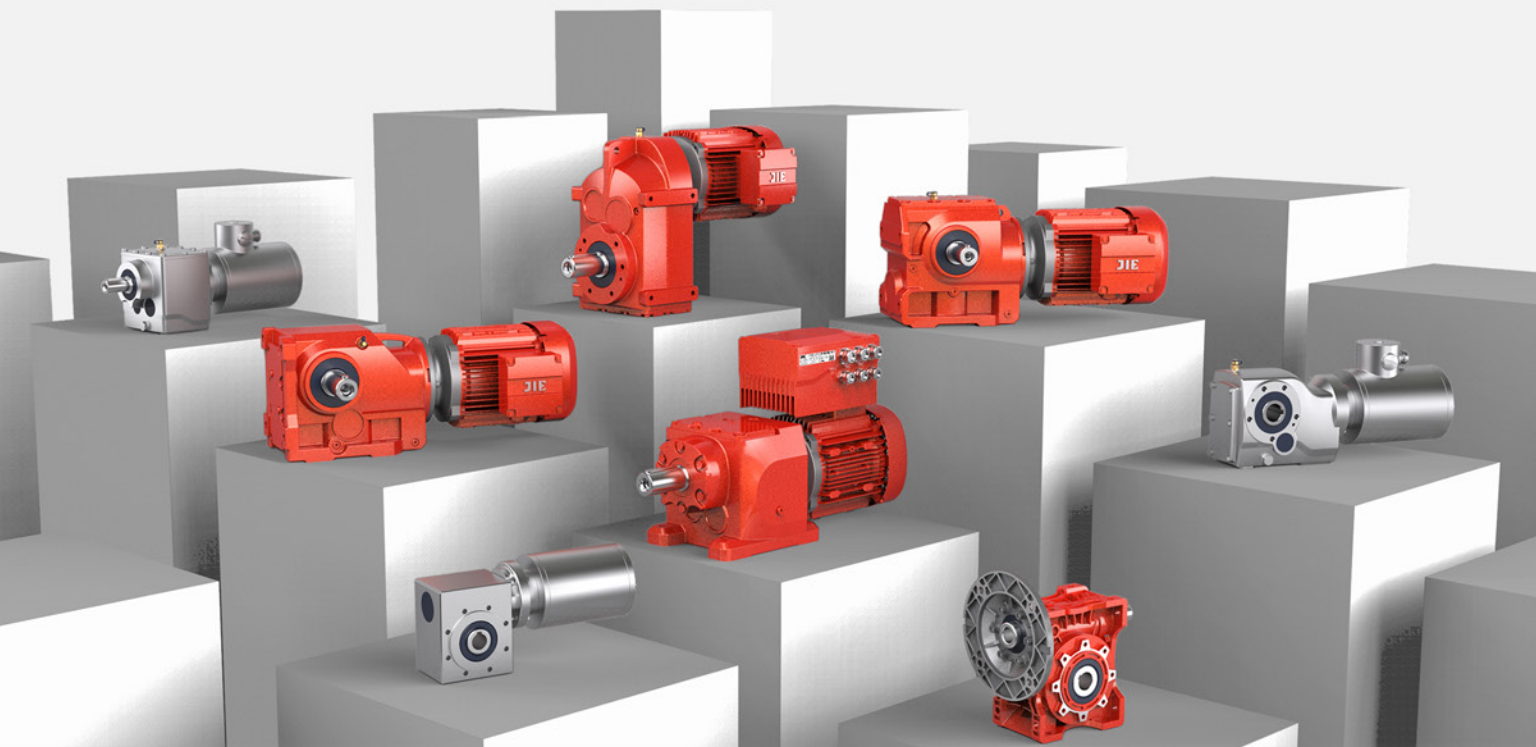
PTE

JIE
JDRIVE

PTDA
Channeling the Power of Industry

IP69K

- Quick Delivery
- Great Service
- Top Quality

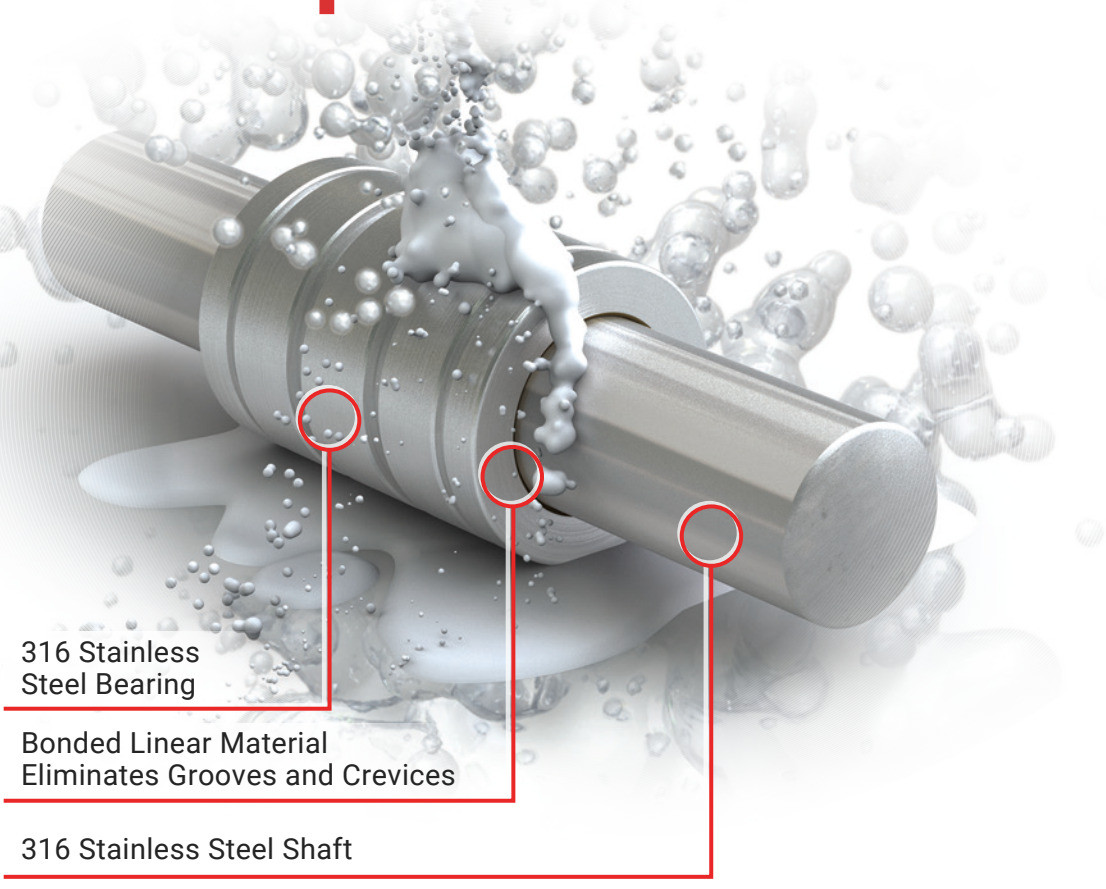


Options are Worm gear unit; Helical inline, Parallel shaft, Helical bevel and Helical worm gearmotor; Available in aluminum, cast iron and stainless steel housing.

JIE USA INC.

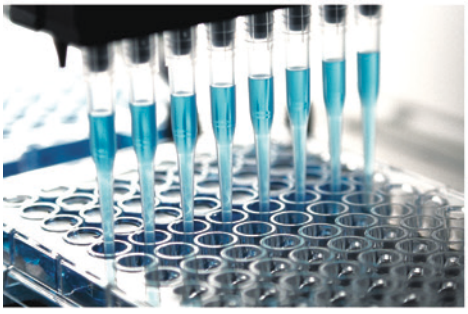
279 Madsen Dr Suite 101, Bloomingdale, IL 60108
www.jie-drives.com | Info@jie-drives.com | +1 630 580 9986

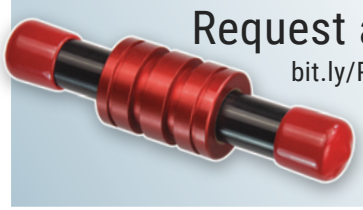
Created for the Most Demanding Washdown Operations



PBC Linear Simplicity® Plain Bearings and Shafts

Maintenance-Free • Wide Temp Range • Vibration Damping • Quiet Operation • Chemical Resistant





Request a **FREE** Sample at:

bit.ly/PTE-Simplicity-Sample

PBC Linear™

6402 E. Rockton Road, Roscoe • Illinois 61073 USA

+1.800.962.8979 • pbclinear.com