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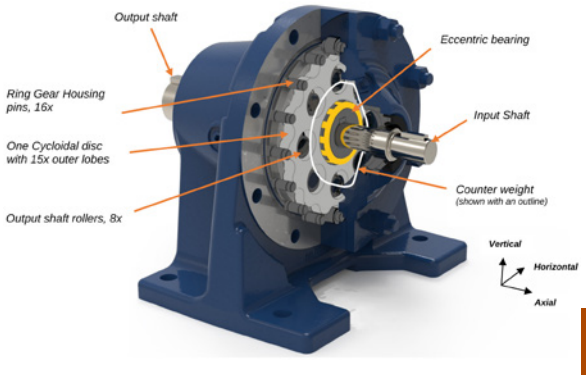

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BRAIN TEASER

Uphill Both Ways?

A gear drive in a wind turbine nacelle transmits torque from the rotor to the generator at 97 percent efficiency. During low-wind conditions, the grid back-drives the generator to keep the rotor spinning and avoid flat-spotting the main bearing.

Question:

Is the gearbox still 97 percent efficient when power flows in reverse?

Join the discussion

Comment at
linkedin.com/company/power-transmission-engineering
on LinkedIn or use
#PTEBrainTeaser
to share your answer.

Selected responses may be featured in an upcoming issue.
Answer revealed in the next issue.

Last issue we asked: A gearbox bearing is running within capacity. The system redesign requires either doubling the shaft speed or doubling the radial load. Which reduces L10 life more?

Answer: Doubling the load. The basic L10 life equation shows bearing life is inversely proportional to speed but inversely proportional to the cube of the load (for ball bearings). Double the speed, life drops by half. Double the load, life drops by roughly 87 percent. The same bearing will yield very different consequences.

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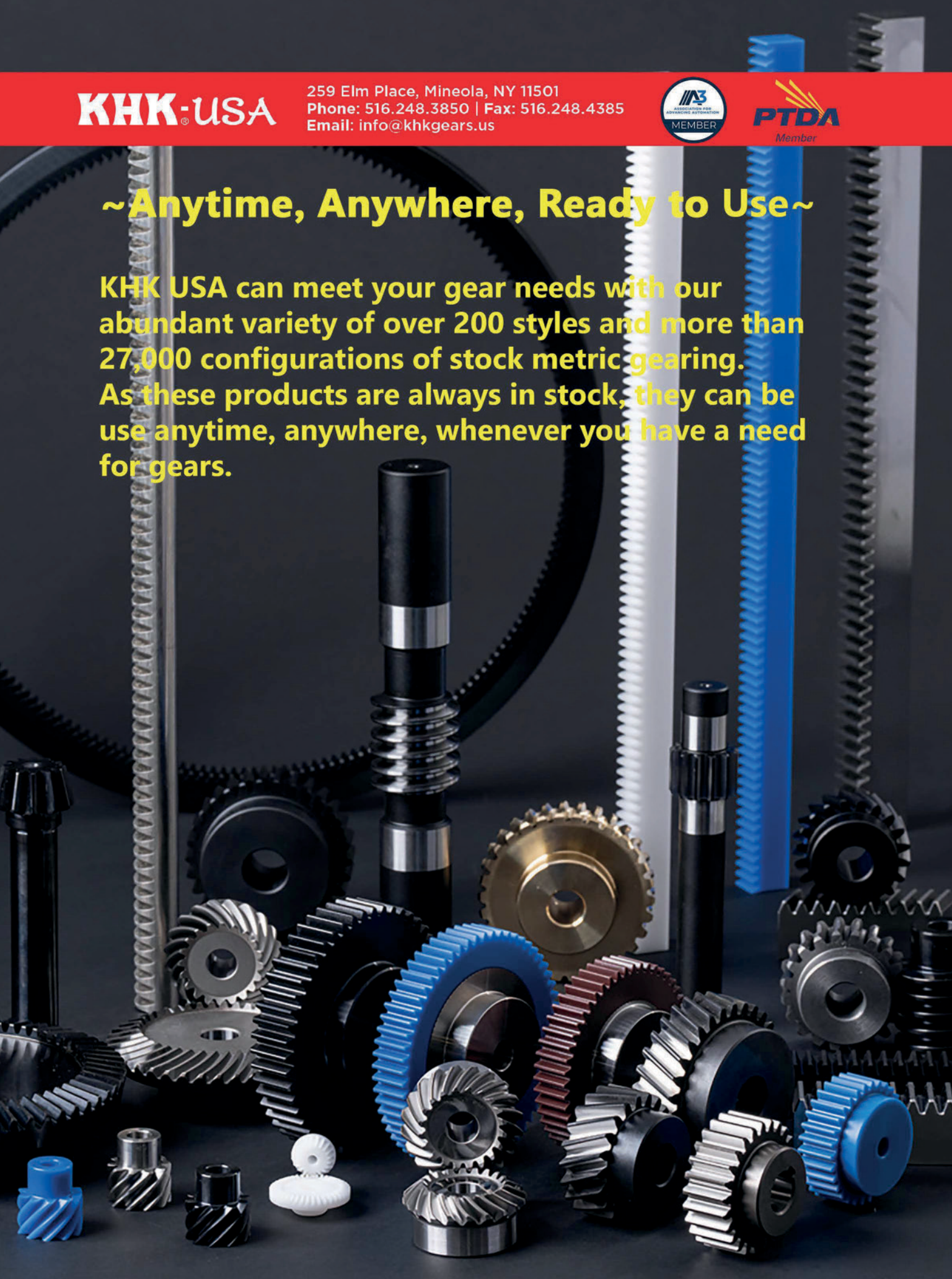

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WindEnergy Hamburg is tailored to address the major issues facing the international wind energy sector. It brings together a high-caliber, professional audience and exhibitors demonstrating their innovations and solutions from across the entire value chain of the wind industry.

powertransmission.com/wind-energy-hamburg-2026-extra

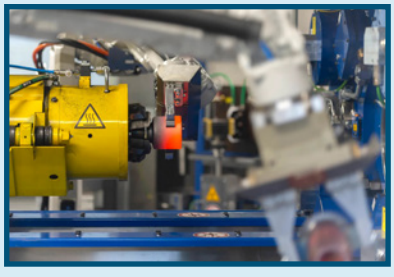
MPIF Releases State of the PM Industry

The global powder metallurgy (PM) industry is navigating what can best be described as a period of "glorious uncertainty," driven by political upheaval, trade disruptions, technological shifts, sustainability challenges, and geopolitical conflict. These forces are reshaping metal powder technologies, including conventional press-and-sinter PM, metal injection molding (MIM), and metal additive manufacturing (AM).

powertransmission.com/mpif-releases-state-of-the-pm-industry

AS SEEN IN *GEAR TECHNOLOGY*

Gear Forging Round-Up 2026



Forged gears beat cut gears because of grain flow. Machining a gear from bar or plate cuts through the material's fiber structure right at the tooth flanks, where bending fatigue does its damage. A near-net or net-forged tooth keeps that fiber running along the profile, which reinforces the root fillet and the tooth's beam strength.

geartechnology.com/gear-forging-round-up-2026

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A Flender aerator gearbox at a municipal water treatment plant being removed from service for a rush rebuild by an Atlanta Gear Works field services team. (Image: Atlanta Gear Works)

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Lucy, Ethel and the Bonbon Paradox

Matthew Jaster, Director, Editorial Content

Science fiction author and journalist Cory Doctorow is quoted in his latest book *The Reverse Centaur's Guide to Life After AI* that "SF writers make lousy prophets, but we can be pretty good technology critics." The man responsible for the weblog *Boing Boing* and an informative newsletter at *Pluralistic.net* has recently produced a 222-page guide to thinking about artificial intelligence before it's too late.

It's just the kind of critical distance my brain needs before walking into IMTS 2026 this year. How many times will we hear phrases like "Building an AI roadmap," "AI practical steps," and/or "AI in real world applications," during the show?

In Doctorow's book he kindly breaks down the AI journey into two very distinct categories: the centaurs and the reverse centaurs. In the academic study of automation, a centaur is a person who is *assisted* by a machine; examples include riding a bicycle, driving a car, and using the mute button on your television set during commercials.

A reverse centaur is a human conscripted into acting as an assistant *to* a machine. He cites a classic *I Love Lucy* episode as a prime example of this:

"Lucy and Ethel are working on an assembly line at a chocolate factory, taking bonbons off the belt and wrapping them in paper. As the belt goes faster and faster, Lucy and Ethel have to work at superhuman speed. They're reverse centaurs: the machine can move the chocolates from one place to another, but it needs a human to pack them into the box, and the humans who act as an assistant are made to work at a pace that exceeds all human capacity until calamity ensues."

The two characters stuffing their faces with bonbons is pure sitcom gold, but in the context of automation and manufacturing today, the thought of humans trying to keep up with the shenanigans of machines is material specifically tailored to horror movies.

The quote that really resonates with me from Doctorow's book is the following, "Automation isn't necessarily the enemy of warehouse work: there's nothing wrong with a forklift! The difference between automation that helps a warehouse worker and automation that torments that worker is whether the worker gets to choose where, when, and how to use that information."

Stories about warehouse employees trying to keep up with the demands of robots and machines in shipping departments, for example, are sparking some much-needed debate on the right path forward in terms of both safety and sanity. And how many articles have you read recently where human workers were fired due to automation programs only to be rehired three months later?

IMTS 2026 is going to be another chapter in the Wild West of AI. AI can detect errors faster than humans and can be utilized in predictive maintenance to foresee and schedule fixes *before* bearings, motors and gear drives fail. There's no denying the positive impact it can have if used correctly. However, it could also shove bonbons down a conveyor line at a speed that no sweet tooth on the planet would ever be able to manage effectively.

At the end of the day, the future of AI is what we make of it. In a world full of centaurs and reverse centaurs the notion that humanity still has a choice in how this all plays out is the headline I'm sticking with.

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RENISHAW
Brings Precision, Productivity and Automation to IMTS

Renishaw will showcase a comprehensive portfolio of manufacturing technologies at IMTS 2026, Sept. 14–19 in Chicago, demonstrating how manufacturers can improve precision, increase productivity, and accelerate automation across the production lifecycle.

Featured technologies include new machine tool probing systems, calibration solutions, shop-floor gauging, intelligent process development software, and metal additive manufacturing systems. They all provide attendees with practical solutions for improving quality, optimizing processes and enabling smarter manufacturing.

Renishaw Central Delivers the Factory of the Future, Today

A manufacturing connectivity and data platform, Renishaw Central is poised to transform the productivity, capability, and efficiency of manufacturing operations. The data-driven manufacturing solution brings the power of connectivity to the machine shop floor, resulting in highly efficient, productive operations with optimized processes, reduced downtime and minimized waste. Renishaw will demonstrate how the platform delivers the factory of the future at IMTS.

RUP60 and RMP400S Machine Tool Probing Solutions

Renishaw will present the RUP60, an advanced ultrasonic thickness measurement probe for 3-axis and 5-axis CNC machine tools. The new probe simplifies the measurement of large parts where access is limited to a single side, removing the need to move parts to specialist measurement equipment or perform manual inspection on the machine. The RUP60 allows for an entirely automated inspection and verification process, which reduces operator involvement and provides quick, traceable results, without the need for specialized training.

Combining touch-trigger measurement, scanning and surface finish verification in one device, the RMP400S is Renishaw's most versatile probing solution to date. It uses Renishaw's patented strain gauge technology to achieve a repeatability of 0.25 µm 2 σ and surface finish Ra of 0.5 µm. The RMP400S enhances on-machine measurement capabilities by delivering high-density scanning data for both form and surface finish verification. Its advanced functionality supports improved in-process control directly on the machine, helping engineers streamline inspection workflows.

XM-60 Multi-Axis Calibrator

The XM-60 multi-axis calibrator simplifies machine tool calibration by measuring all six degrees of freedom from a single set-up. The system quickly captures linear positioning, straightness, pitch, yaw and roll errors, allowing manufacturers to improve machine accuracy, reduce downtime, and increase production quality. When combined with Renishaw's *CARTO* software, the XM-60 provides powerful analysis and compensation tools for machine performance optimization.

Equator-X Gauging System

The Equator-X dual-method gauging system combines high-speed comparative gauging with traceable absolute measurement in a single shop-floor platform. Manufacturers can switch between inspection methods to match changing production requirements while maintaining high throughput and exceptional measurement confidence. Designed for operation directly on the shop floor, the Equator-X gauge delivers fast inspection, process control and immediate manufacturing feedback to improve quality and productivity.

Industrial Robot Calibration and Maintenance Solutions

Renishaw will demonstrate its commitment to advancing industrial automation with live demonstrations of cell recovery and in-field robot calibration, alongside a range of innovative products designed to improve productivity and process control. The interactive RCS demo cell showcases how Renishaw's solutions simplify robot set-up, calibration, and recovery, helping manufacturers achieve greater accuracy and efficiency, and increase production uptime.

RenAM 500 Series Metal Additive Manufacturing Systems

The RenAM 500 series is Renishaw's family of laser powder bed fusion systems designed for industrial metal additive manufacturing. Built for high productivity, repeatability and process control, the systems enable manufacturers to produce complex, high-value components with consistent quality. Advanced process monitoring, automated powder handling and flexible system configurations make the RenAM 500 series ideal for aerospace, medical, energy and precision manufacturing applications.

Encoders for Position and Motion Control

Renishaw will further highlight its portfolio of position and motion control encoders, which play a critical role in robotic performance. These encoders provide precise feedback for robotic joints, enabling accurate positioning, smooth motion control, and repeatable performance across a wide range of applications.

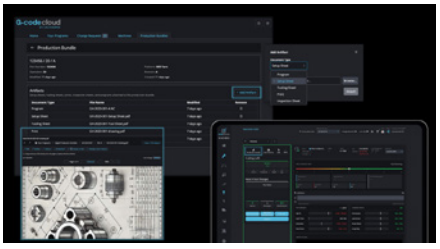
Renishaw's manufacturing technologies will be displayed at IMTS at

Booths #134314 & #134524 (Quality Assurance); Additive Manufacturing Booth #338469; Student Summit Booth #211402.

renishaw.com

DATANOMIX

Offers Digital Production Bundles at IMTS



In most precision shops, the print is clipped to the bench, the setup sheet is in someone's email, and the operator walks back to the office to confirm they're on the right rev. That's one of the problems Datanomix is solving at IMTS 2026. Datanomix will showcase Digital Production Bundles at IMTS 2026, Booth #135521, and prove what happens when the shop floor goes paperless.

"Walk any shop floor, and you'll see it: the print clipped to the bench, the setup sheet buried in someone's email, and an operator halfway back to the office just to confirm they're running the right rev," said Greg McHale, founder and CEO of Datanomix. "That's not a process; That's a scavenger hunt. Datanomix Digital Production Bundles put the right information to the right people and machine, at the right time."

Built on the G-Code Cloud + DNC platform, each bundle delivers a complete part recipe to the operator via the Machine Heads Up Display (HUD)—the same workspace they already use for production monitoring. Every asset in the bundle is automatically paired by part number and machine, so an operator can't pull last month's revision or a setup sheet intended for a different cell. Every change is logged with who, what, when, and why, so engineering, planning, ops, and operators all work from a single source of truth.

datanomix.io

KUKA ROBOTICS

Showcases Scalable Machine Tending Robotics at IMTS 2026

Kuka Robotics will display its advanced robotic automation solutions for machine tool tending with the company's system integrator, Formic Automation, at IMTS 2026. Visitors to Booth #236807 in the North Building will experience live demonstrations that highlight how Kuka is making automation easier

for manufacturers to adopt robotic machine tending through a scalable, service-based approach that reduces complexity and supports evolving production needs.

The real-world demonstration with Formic Automation will feature a KR Cybertech robot integrated with an EMAG WPG 7 cylindrical grinding machine. Designed for high-precision grinding applications, the WPG 7 combines rigid machine construction with optimized thermal stability to enhance grinding accuracy and process consistency. The machine achieves cylindricity accuracy deviations of less than one micrometer through continuous in-process measurement systems from Marposs, along with advanced monitoring and control technologies.

At the center of the demonstration is Kuka's machine-tending automation technology paired with Formic's Robotics-as-a-Service (RaaS) model, which enables manufacturers to adopt automation without significant capital expenditure. The collaboration highlights how flexible automation helps manufacturers address labor shortages, respond to increased production demands and expand their machining capabilities.

kuka.com

SMC CORPORATION OF AMERICA

Highlights Automated Systems and Robotics at IMTS 2026

SMC Corporation of America will exhibit at IMTS Booth #135420 in the East Hall. IMTS provides a convenient 'one stop shop' venue where you can meet with world-class suppliers, see the latest industry products and developments, and find the tools to improve productivity, increase profits and discover new solutions to all of your metal forming, fabricating, welding and finishing needs. Components in SMC's portfolio includes chillers, sensors, motors, controllers, hydraulic cylinders, grippers, actuators, valves and more.

Key focus areas—including industrial AI, digital connectivity, and scalable system design—highlight the move toward more adaptive, data-informed operations. Manufacturers continue to face increasing pressure to improve throughput while reducing energy consumption and system complexity. Over the past year, the acceleration of AI-driven technologies, advancements in robotics, and growth of connected manufacturing systems have raised expectations for how production environments operate and scale.

SMC addresses these challenges through a combination of broad product capability and a disciplined approach to product development. At IMTS, SMC specialists will be on hand to discuss application challenges, provide technical guidance, and demonstrate solutions that support evolving production demands.

smcusa.com

JORGENSEN

Brings Advanced FlexFiltration Coolant Management System to IMTS 2026

At IMTS 2026, chip and coolant handling experts Jorgensen Conveyor and Filtration Solutions will highlight their expanded FlexFiltration coolant management systems that extend coolant life, enhance part

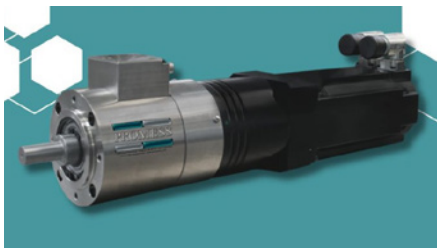
finishes, and reduce maintenance procedures and costs. In Booth #338009, Jorgensen will feature complete, fully automated systems that showcases compact modular designs with advanced customization for integration versatility in coolant filtration and monitoring.

One of the FlexFiltration coolant management systems on display features a conveyor with an integrated coolant tank designed to fit on a high-speed 5-axis CNC machine tool. This solution—sold directly through OEM machine tool builders and dealers—incorporates an integrated FlexFiltration tank that maintains coolant clarity down to or below 10 microns, a chip conveyor, filter media and accessories. All of which deliver an adaptable system designed to fit different machining needs. The customizable system also features Jorgensen's PermaClean advanced filtration to eliminate sludge buildup in the coolant tank. PermaClean is paired with multi-stage cyclonic filtration for a consumables-free design, which eliminates non-cut time for tank maintenance.

jorgensenconveyors.com

PROMESS
Introduces Press System and Control Platform at IMTS

Promess, founded in 1984 and based in Brighton, MI, designs and manufactures assembly press and torque systems used by manufacturers to monitor and control the quality of their assembly processes. The company introduced the first servo-electric assembly press in the late 1990s and has served the global manufacturing industry across automotive, aerospace, medical, defense, and general industrial markets since.



The M-Series and UltraPRO 2 are designed to reduce the time and complexity involved in getting a Promess system into production. Component replacement no longer requires manual recalibration—the system stores its own calibration data and recovers after a swap. Installation requires fewer cables and fewer connections than prior-generation systems. And because the new control platform is built from independently modifiable software, Promess can respond to application-specific needs faster than was possible under the previous architecture.

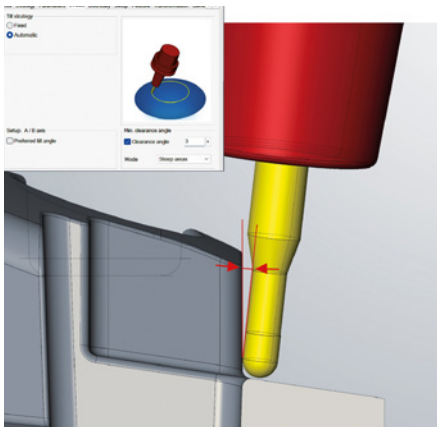
The M-Series also gives Promess a cleaner product line to grow from. The modular Cartridge that defines the new system is designed to expand over time, covering additional press force ranges and, in development now, a torque variant that will bring the functionality of the Promess TorquePRO to the new platform.

For manufacturers already running Promess equipment, UltraPRO 2 is designed to be familiar. The operating environment carries forward from the first-generation UltraPRO, which remains fully supported and available. The new platform is the foundation for future Promess product development, including capabilities not yet at launch.

Three M-Series configurations will be on display at Promess Booth #236615 at IMTS. First customer shipments are expected in Q1 2027.

promessinc.com

OPEN MIND TECHNOLOGIES
Highlights CAM/CAD Software at IMTS 2026



Open Mind Technologies, a leading developer of CAD/CAM software solutions worldwide, announced it will highlight the latest *hyperMILL 2026 CAD/CAM Software Suite* at IMTS Booth #133351.

Open Mind will be showcasing the recently introduced *hyperMILL 2026*, featuring a broad range of new and enhanced machining strategies and programming capabilities designed to increase programming speed, machining reliability and surface quality. The latest software suite delivers significant advancements for 2.5D, 3D, precision 5-axis and mill/turn machining applications, enabling manufacturers to achieve greater productivity and process control and many partner booths.

Attendees visiting Open Mind at IMTS 2026 will be able to see tutorial demonstrations of *hyperMILL 2026* technologies and learn how the latest CAD/CAM innovations can improve productivity, process reliability and machining performance across a wide range of manufacturing applications. Unique parts made using *hyperMILL* will also be on display in the booth.

New and Enhanced Finishing Technologies

The latest *hyperMILL 2026* suite introduces major advancements in Rest Machining technology that optimize toolpaths and create smoother machining transitions by automatically detecting rest material while accounting for clearance and feed specifications. The 5-axis Rest Machining strategy has been completely redesigned with new calculation algorithms for "Z-Level," "Parallel" and "Normal" machining strategies, ensuring precise and reliable machining of complex geometries.

Further improvements include optimized 5-axis cutter orientation determination and enhanced collision avoidance for smoother simultaneous movements. A new "Minimum Clearance Angle" option gives programmers even greater tool control by ensuring machining is performed with a defined clearance angle between the tool shank and workpiece.

For more reliable deburring of cross holes and internal threads, a newly designed "Hole Brush" tool improves the "Hole Brushing" strategy. New capabilities automatically alternate spindle rotation direction during multiple brushing passes to further improve process reliability. In addition, both the 5-axis Deburring and 5-axis Hole Deburring strategies now automatically optimize contour sequences and milling directions, significantly reducing programming time.

When performing 5-axis multi-blade point milling, *hyperMILL 2026* delivers more robust toolpaths and smoother machine movements for complex impeller and blisk geometries. The completely redesigned camberline mode for tool orientation determination now supports additional applications including fuel pump and inducer geometries.

A new "2D Hale Machining" strategy produces flawless surfaces without processing marks across the sealing direction, making it ideal for scratch-free finishing applications such as semiconductor and watch manufacturing. The strategy provides an alternative to conventional milling because material removal occurs without active spindle speed while the spindle axis continuously aligns the tool edge to the contour. Hale Machining is currently available for machines equipped with Siemens controls.

Expanded Programming and Automation Capabilities

Programming in *hyperMILL 2026* has also been significantly enhanced with new capabilities for complex machining applications. For the first time in *hyperMILL* and *hyperMILL VIRTUAL Machining*, programmers can easily program right-angle heads in *hyperMILL TOOL Builder* while avoiding costly collisions through detailed simulation and collision tracking.

New tool types with complex geometries can now be created more quickly and reliably using enhanced automation features in *TOOL Builder*. New tool types include Hole Brush, Hale Tool, Indexable Cutter with Shoulder Mill Inserts, Indexable Cutter with Face Mill Inserts, Helical Thread Drill/Mill Cutter and Front/Back Chamfered Cutter.

The new "Minimum Clearance Angle" capability in *hyperMILL* "5-axis Automatic Mode" also further simplifies reliable 5-axis programming by automatically determining optimal tool positions and efficiently utilizing indexed and simultaneous machine movements based on analysis of the complete toolpath.

Also new in *hyperMILL 2026*, the enhanced "CAM Plan Turning" strategy for turned and mill-turned parts significantly reduces programming time and increases accuracy. CAM Plan Turning automatically generates production-ready contours, recognizes machining features and provides the required machining areas for NC programming, allowing programmers to consistently enrich turning contours with all relevant manufacturing information.

"Open Mind continuously invests in research and development based on customer feedback and evolving market requirements," said Alan Levine, managing director of Open Mind Technologies USA, Inc. "With *hyperMILL 2026*, we are providing customers with powerful new programming technologies, enhanced finishing strategies and improved automation capabilities that significantly increase machining efficiency, accuracy and reliability."

openmind-tech.com

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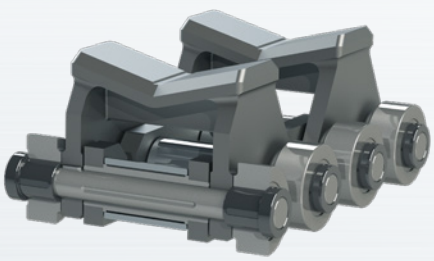

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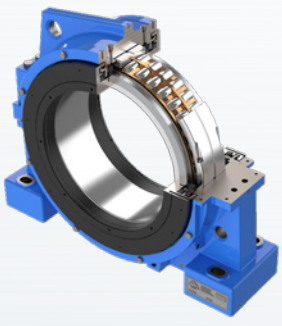
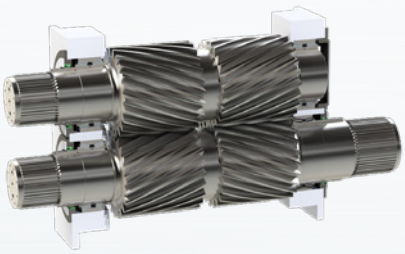


ACB
ATLANTIC CUSTOM BEARINGS



MGS GEARS

Inside the Lab

How SKF testing and investigation helps solve bearing failures

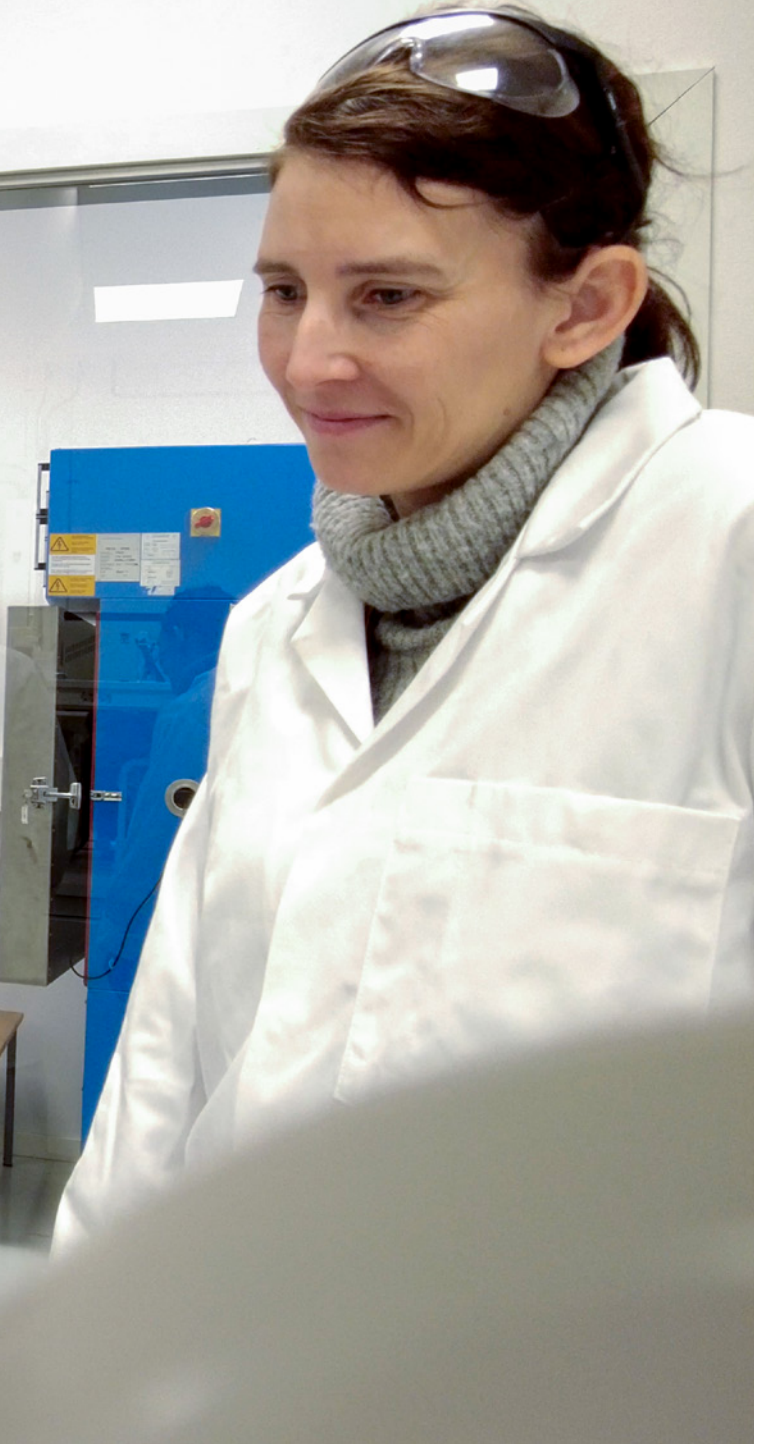
Jennifer Jensen, Associate Editor

Decoding lubricant performance: Elin Liden, Fredrik Reinholdsson and Maria Odqvist review chemical analysis results for lubricants in hybrid bearings at SKF Global Labs Sweden. **(All images: SKF)**

Testing is a powerful tool for improving equipment reliability and reducing the risk of costly, unplanned downtime. When a bearing fails, it's important to figure out why. Without an investigation or testing to determine the cause, there is a greater likelihood that the same problem will happen again. That's why SKF Global Labs and Testing plays such a critical role in helping customers maximize the performance and service life of their rotating equipment.

Using advanced testing methods and decades of engineering expertise, SKF specialists examine wear patterns, material condition, lubrication performance and operating history to determine exactly what happened and why. They use advanced technologies to validate materials, verify designs and test performance in real-world conditions. Every bearing investigation gives the team valuable insights, helping them understand root causes, prevent future issues and continuously improve their products.

As SKF continues to strengthen its technology leadership, Global Labs and Testing plays a central role in ensuring their products deliver performance, reliability and long-term value for customers, according to Elin Liden, director for Global Product Development and Engineering and for Global Laboratories and Testing.



Putting grease to the test: Joakim Hallberg walks Elin Liden through this specific grease life testing setup at SKF Global Testing Sweden.

"Global Labs and Testing strengthens SKF's innovation by delivering the technical expertise and operational excellence needed to turn complex customer challenges into validated solutions," she said. "Through robust early-stage testing, advanced verification and reliable material investigations, we ensure that new ideas are proven."

Global Labs and Testing supports everything from concept to field performance. They validate materials and suppliers to ensure new steels, lubricants and components meet the right standards. During development, they test new designs to confirm they meet customer requirements. They run life tests to validate long-term performance and support bearing life models. And once products are in the field, they investigate failures and feed insights back into design rules and future product development.

Liden is responsible for operational management of labs in Europe, Middle East and Africa (EMEA). Additionally, she is responsible for the Global PD&E team. In her role, she leads the global team to drive customer-centric innovation across the entire product lifecycle. Along with her team, she also focuses on emerging technological areas such as virtual testing, simulation driven development and digital twins to continue reshaping the future of testing at SKF. The focus is on integrating the physical and virtual worlds to increase speed, reduce cost and deliver more faster, competitive innovation.

In the lab, Liden and her team see a slew of bearing challenges from fatigue and premature failure, wear and surface damage, corrosion, contamination, and lubrication breakdown, plus the effects of demanding conditions like high speed, heavy loads, vibration and temperature extremes.

"A big part of the work is understanding why a bearing underperforms — for example, corrosion appearing inside bearings in harsh washdown environments such as food processing," Liden said.

The goal is to turn these challenges into solutions. So, how do they do that?

The team starts with a detailed bearing analysis and works closely with an application engineer to understand the reasons for the issues, then address that cause directly.

"In some cases, this means that application engineers will suggest a different bearing arrangement, different kinds of seals or sometimes add condition monitoring and in other cases it provides input to the redesign of the bearing," she said.

They combine three complementary capabilities in their testing and validation.

Intelligent and Clean Bearings

Bearing World took place in Dresden, Germany from June 17-18, 2026. Annika Ölme, CTO and senior vice president technology development at SKF opened this year's conference with a keynote address on intelligent and clean bearings.

Ölme said that customers are under increasing pressure to reduce energy use, improve uptime, and make faster, better decisions. That means the value of a bearing can no longer be defined only by geometry or load ratings. It must be measured by how it helps customers improve efficiency, enable insight, operate predictably, and reduce environmental impact.

As industries become more digital, more electrified, and more sustainability-driven, expectations are changing. Bearings remain fundamental, but their role is evolving.

One of the strongest takeaways is that progress in the bearing industry will be shaped through collaboration. For SKF, this reinforces the importance of co-creating with customers, working closely with academic partners, and engaging with a broader ecosystem of like-minded innovators to move faster from insight to application.

This is true not only in bearing research, but also in AI. SKF's recent partnership with Sferical AI reflects this mindset — combining industrial expertise with high-performance AI infrastructure to accelerate work in predictive maintenance, quality control, R&D, and next-generation digital products.

At Bearing World, AI-powered condition monitoring and modeling were part of the broader technical discussion, reflecting a shift in how this industry approaches performance, reliability, and decision-making. The focus is moving from experimentation to AI as a practical way to improve diagnostics, make sense of complex data and support better maintenance decisions.

SKF's condition monitoring solutions combine sensors, analytics, and AI-based tools to detect issues earlier and help customers act before failures occur. The organization's collaborations show how AI can support real operating environments where data volumes are high, and conditions are demanding and actionable insight matters more than raw information.

For me, that is the real promise of AI in our industry, where technology makes industrial knowledge more scalable, more accessible and more useful to customers.

The third and most important takeaway is that intelligent and clean solutions must be anchored in customer needs.

Across industries, customers are under pressure to reduce energy consumption, increase reliability, and deliver on decarbonization targets without compromising performance. This is why topics such as friction reduction, lubrication, and life extension were so prominent throughout the Bearing World event.

For SKF, this is where customer-centric innovation becomes critical. "Intelligent" means helping customers move from reactive to predictive by turning bearing and machine data into earlier insight and better decisions. "Clean" means designing for efficiency, reducing friction, extending life and enabling circularity from the start.

Together, these capabilities help customers reduce energy losses, simplify maintenance, extend asset life, and advance decarbonization in measurable ways.

***Annika* Ölme, CTO and senior vice president technology development at SKF opened Bearing World 2026 with a keynote address on intelligent and clean bearings.**

In the labs, the focus is investigation and analysis—bearing investigation, metallurgical and material analysis, and examining failure modes and materials.

In testing, they verify performance on dedicated test rigs, including purpose-built rigs that replicate field conditions. Alongside both, they use simulation models to model and predict bearing performance, so a design can be studied digitally before and in parallel with physical testing.

"Together, simulation, lab analysis and rig testing let us validate new designs and qualify new suppliers efficiently before they reach the market," she said.

They work closely with other department to help deliver these solutions.

This includes with application engineers and sales to turn a lab finding into a practical customer recommendation, and with product development and metallurgy when an insight calls for a design or material change.

"A lab analysis usually explains the problem; the solution comes from solving it together, in many cases also together with the customer, for instance, pairing an analysis with application engineering to recommend a better-suited solution," she said.

These solutions transfer to their clients and the real world by using their findings as concrete recommendations. Some of these could be a different seal, optimized bearing arrangement or a better application solution. This translates to longer service life, less unplanned downtime and easier maintenance.

"Often the insight also flows back into how the product is designed from the start, so future customers benefit from the new design directly," she added.

One example is related to their SKF Food Line ball bearing units. A customer in the food and beverage industry was having issues with corrosion inside the bearing due to the severe environment caused by the cleaning of the facilities. This became evident after investigations of the bearing.

"SKF worked together with the customer and our distributor to create a new sealing design, which resulted in a large improvement in the service life of the bearing," she said.

At SKF, delivering reliable, high-performing solutions starts long before a product reaches the customer. These capabilities are accelerating innovation, reducing time to market, and ensuring that every SKF solution is backed by solid data and proven reliability.

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The Big Squeeze

JBT Marel produces fresh juice via Nord gearmotors

Nord Drivesystems

A Nord SMI worm gearmotor with a three-phase 1 hp motor drives the Fresh'n Squeeze 1880 machine.
(All images: Nord Drivesystems)

Few things say good morning like a glass of fresh orange juice. Thanks to the rise of in-store juicing machines, you no longer need an orange grove out back, let alone a hand press and strong forearms to enjoy one. Just walk into any Sam's Club in the country and you'll find gallons of fresh juice in the cooler, squeezed on-site that same day.

The machines behind all that juice come from JBT Marel. From its operation in Lakeland, FL, the food and beverage equipment manufacturer builds the Fresh'n Squeeze family of point-of-sale juicers, self-contained machines that turn whole citrus fruit into clean, great-tasting juice on demand.

Leveraging JBT Marel's patented whole-fruit extraction technology, Fresh'n Squeeze systems deliver high juice yields, exceptional flavor, and the ability for retailers to produce fresh juice directly at the point of sale.

It's a win for everyone involved. Retailers can offer juice made in-house rather than trucked in from a bottler, consumers no longer must wonder where their juice was made, and JBT Marel can continue serving an important market segment, just as it has for many decades.

The newest member of its juicer family is the Fresh'n Squeeze 1800, a compact unit aimed at hotels, cafes, juice bars, and grocery stores. Yet several years ago, as JBT Marel continued evolving its citrus juicer portfolio, the team faced an important design challenge. The gearmotor supplier for an earlier version of 1800 announced it was leaving the single-phase motor business. This created a need for a replacement that could fit within a highly constrained installation space while meeting the performance requirements of the application.

Fortunately, Nord Drivesystems had just the thing, kicking off a partnership that has since spread across all the juicer manufacturer's new equipment.

From Spray Pumps to Citrus

JBT Marel traces its roots to 1884, when inventor John Bean developed a continuous spray pump to combat scale in his California almond orchards. The company that grew from his invention—John Bean Technologies—became JBT Marel in January 2025 after its merger with the Icelandic food-processing leader Marel, making it a global provider of equipment, software, and services for the food and beverage industry. In fact, its technology touches nearly every aisle of the supermarket, from poultry, meat, and seafood to prepared foods, dairy, and beverages.

In Lakeland, though, citrus rules. The company's industrial extractors process roughly 75 percent of the world's orange juice, and the same patented whole-fruit extraction principle used in those machines—developed in the 1930s and refined ever since—powers every Fresh'n Squeeze juicer. That technology helps Fresh'n Squeeze systems maximize the juice squeezed from each fruit while producing clean, great-tasting juice, bringing decades of citrus-processing expertise to retail and foodservice environments.

Ricky Negrón, Nord's district sales manager based in Clearwater, FL, supports JBT Marel and picks up the story of how the two companies met. "The original equipment was using a competitor's gearmotor, but when that supplier moved away from single-phase in 2017, JBT had a real need on its hands," he says. "The biggest obstacle back then was size. The machine was small, and the gearmotor was installed in a very tight cavity, so you needed a gearbox that would not only work but also fit in the available space. Nord had one, and that's really what opened the doors for us."

Wade Roberts, mechanical design engineer for Fresh'n Squeeze at JBT Marel, was there at the start. "We were redesigning our mid-sized Multi-Fruit Juicer, or MFJ, when we learned our existing supplier was moving away from single-phase motors," he says. "That prompted us to evaluate alternatives, and the Nord motor looked like a strong fit for the application, and from there, we've established a great relationship. We've long since begun using Nord in all our new equipment designs."

Maximizing Value

To appreciate what those gearmotors are up against, it helps to understand how a Fresh'n Squeeze machine works. Most competing juicers use a cut-and-press design that slices the fruit in half, then pushes each half against a rotating press. It's a simple, inexpensive approach, but one with consequences for flavor. "You're pressing on the entire orange, which means you get most of the oil on the peel's surface," Roberts explains.

In JBT Marel's whole-fruit extraction process, a pair of specially shaped cups encase the fruit, peel and all. A cutter opens a small hole in the bottom of the orange, and as the cups close, the fruit's contents are forced through the hole into a strainer tube. A plunger then compresses everything into a volume measuring roughly an inch across, ejecting the juice through the tube's tiny perforations—ranging from 0.028 in. to 0.055 in. in diameter—while the seeds, membrane, and excess pulp exit separately. The result is clean juice free of oil-induced bitterness, and up to 50 percent more juice per fruit than cut-and-press machines can deliver. That combination of flavor and yield is one of the key advantages of the Fresh'n Squeeze platform, helping operators maximize the value of every piece of fruit while delivering a premium consumer experience.

Better yet, one set of components handles everything. "Lemons, limes, grapefruit, oranges, tangerines, mandarins—any kind of citrus you can think of is juiced with the same set of components," Roberts points out. "The only thing we change is the strainer tube, and that just controls how much pulp you want in the juice."

The Fresh'n Squeeze platform maximizes the value of every piece of fruit while delivering a premium consumer experience.

The 1800 is the smallest machine in the Fresh'n Squeeze lineup, sitting below the mid-sized MFJ. It processes up to 18 fruits per minute, yielding 50 ounces of juice, and accepts fruits up to 3.25 in. in diameter. Operators simply load the hopper, which holds around 20 pounds of fruit, and press a button. And with just six removable parts, each hose down safe, cleanup is equally easy.

Driving it all is a Nord SMI worm gearmotor with a three-phase 1 hp motor, while the MFJ, found in Sam's Club stores nationwide, carries a 1.5 hp version of the same right-angle drive. Both operate on a variable frequency drive (VFD), an arrangement that gives each machine multiple speed settings and earned the company an unexpected piece of intellectual property.

"When we did the design for the second-gen MFJ, we moved to three-phase and put a VFD in there," Roberts recalls. "We actually have a patent on running a three-phase motor with a VFD on a juice machine."

And what happens if an operator drops in an oversized orange? Not much, as it turns out. "If it's too big, you'll know because it just won't go into the cup—you just pull it out and keep running," he says, pointing out that most customers sidestep this question entirely by ordering fruit to size, something many people outside the produce business might never have considered. Roberts explains that all boxes of fruit weigh 40 pounds, and you buy them by the number of fruits in the box—a 72-count box contains 72 fruits; a 138-count box has 138, and so on. "You can specify whatever size you want."

The Proof Is in the Pour

He goes on to point out that the Sam's Club machines provide a punishing endurance test: operating seven days a week and four hours a day, they generate a tremendous volume of juice. But with more than 1,000 units in the field, failures are notable for their absence. "I can count on one hand the number of times we've had to change out a motor," Roberts asserts. "And on the rare occasion we've had an issue, Ricky and the Nord support team are always quick to help us out."

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Part of that longevity comes down to the gearmotor's ability to shrug off citrus oil, an acidic compound aggressive enough to attack aluminum. The MFJ's drives wear Nord's NSD2+ coating, and the results speak for themselves. "Many of those machines have been in the field for eight years now," Roberts says.

"You can take a wet rag, wipe the citrus oil off, and that paint still looks brand new. I can tell you from extensive experience that citrus oil eats straight through aluminum over time, and that coating holds up well."

Nord's online tools have also earned a permanent place in the company's design workflow. "myNORD allows us to get the exact motor we want for every application and get it quoted pretty much on the spot," he adds. "It's one of the many reasons we began using Nord for all of our gearmotors."

The view from the purchasing department is largely the same. Sergio Correa, site procurement manager at JBT Marel, has spent nearly twelve years buying Nord gearmotors, the overall impression reflects a highly reliable and solutions-oriented partnership. Nord has consistently demonstrated strong performance from the outset, with dependable lead times, responsive customer service, and a proactive approach to problem solving.

Their team works collaboratively to address challenges efficiently, helping streamline procurement processes and ensure operational continuity.

nord.com

Make it Your Own

Thomson Industries examines affordable motion control options

Thomson Industries

Customization may not always be top of mind when machine designers are selecting motion control vendors. The hope is usually that they will find exactly what they need in the catalog and avoid what they believe to be the higher costs, delays and risks associated with custom solutions. But, given that more than 25 percent of motion system projects end up requiring at least some degree of customization, it could be beneficial to prepare for that eventuality from the outset.

Including customization expertise on your list of vendor selection criteria could help avoid higher costs and delays if your application should require some modification down the road. And, as you learn about the varying customization capabilities of different vendors, you might just find that customization can be much faster, less expensive and not as risky as you may have thought.

The most important question to ask before closing on any motion control purchase is "What happens if we can't get my needs met with standard products?" A few key factors to consider include:

- **Commitment.** For some vendors, customization is part of their business model, while for others, it is something to be avoided at all costs. If the vendor website has dedicated customization pages with detailed lists of characteristics that can be customized, you are probably in good hands. If, on the other hand, there is little or no mention of customization, you should find out why. It could be because of deficiencies in any of the other areas mentioned below on this list.
- **Experience.** How often have they had to modify a product? Can they give examples? How did the need for customization impact cost and delivery?
- **Capability and scale.** Do they have any special equipment for customization? What does it do? What is the minimum number of potential products for which they would consider customization? Are they set up to handle smaller batch runs or will they customize only for large product runs?

- **Supply chain flexibility**. Are they vertically integrated so that they build most of their subcomponents from raw material, or will they be waiting for your parts to arrive on the next container boat?
- **Process**. Can they give budgetary quotes right away? How long does it typically take to get a quote for a nonstandard product? Will there be a dedicated engineer? Can you build the prototype online? Can the vendor produce the product directly from a CAD model?
- **Engineering problem-solving**. After all else is considered, perhaps the most important factor is the creativity of the vendor's engineering team in terms of helping you reach an optimal solution. Will they take the time to understand your needs?

While it is common for machine builders to think of customization as an all-or-none situation, many needs can be met with a relatively simple modification of standard products, which, depending on the vendor's experience, can often be delivered in days rather than weeks or months. Sometimes all that is needed are some special machined shafts, connectors or mounting ends. Here are some examples of linear motion customizations that have helped designers adapt to irregular spaces, improve ergonomics or reduce costs.

Adapting to Irregular Spaces

Usually, the need for customization often emerges after the project begins. For example, a company that specializes in customizing semi-trailers required several modifications to adapt actuators for use in ramps, stairs and movable floor assemblies. Fitting ramp lift actuators inside the trailer wall required rotating the motor 90 degrees. The ability to mount actuators within custom ramp frames while still connecting to the standard mounting points required extending the actuator tube by four inches. Simplifying future maintenance involved retrofitting the wiring connections with an easily detachable harness.

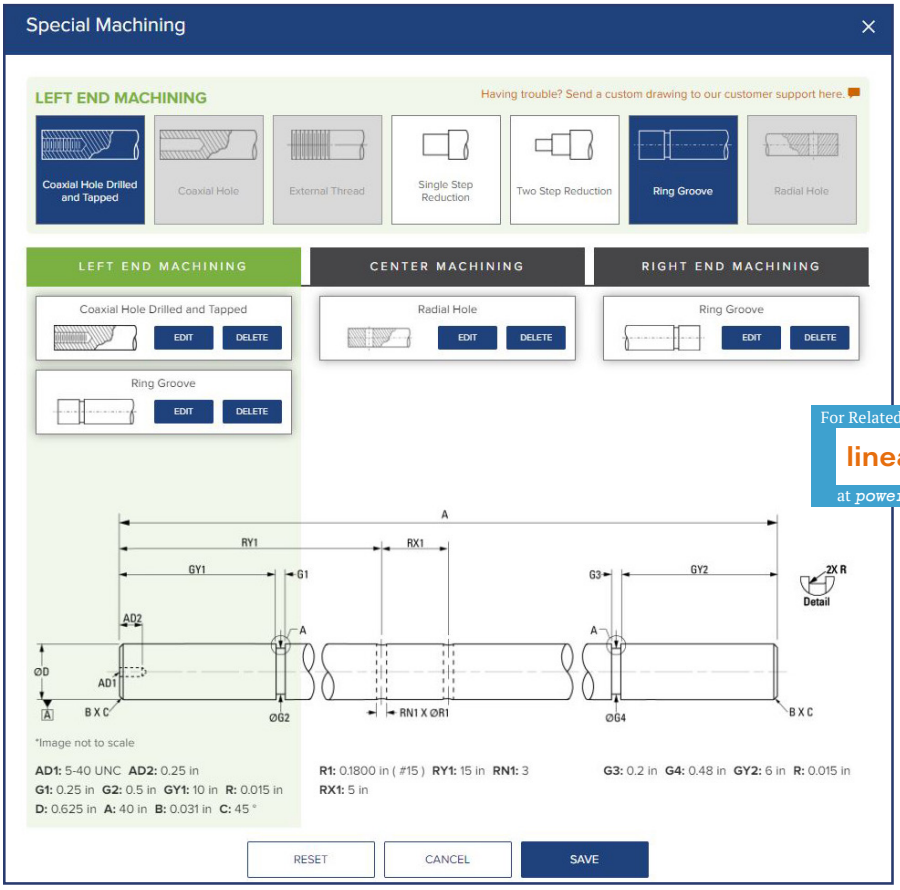
> In these days, in which machine designers are having to do more, faster and with fewer people, the more uncertainty they can drive out of the process, the greater their chance of sustained success.

Collaborating with a manufacturer that has vast experience in customizing linear motion components produces both immediate benefits for the design project as well as long-term benefits for the application. **(All images: Thomson Industries)**

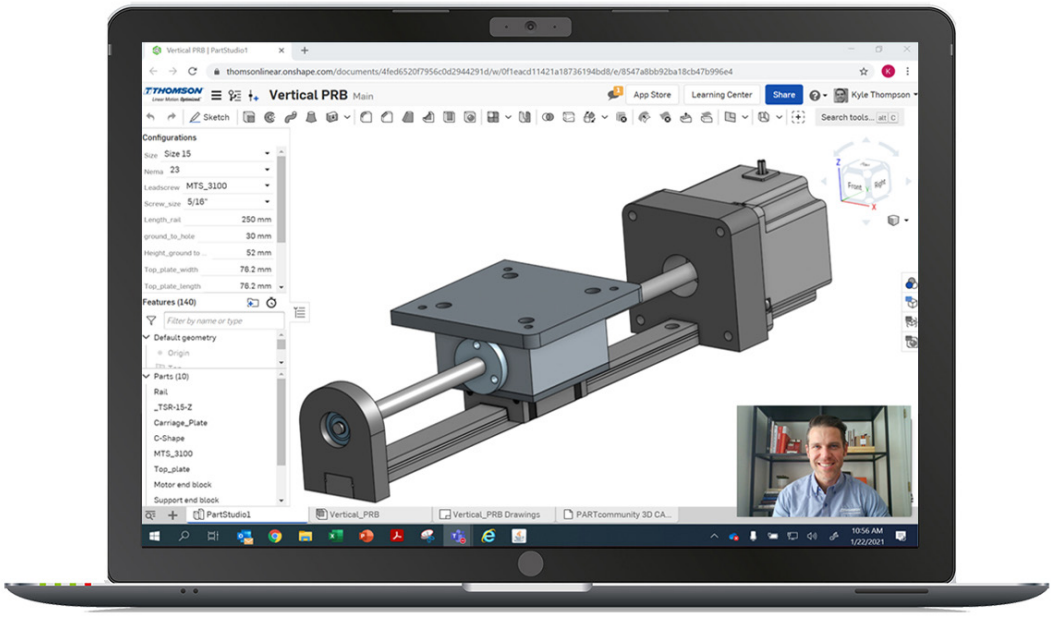
Custom Linear Motion Assemblies

Thomson Linear has created a handy chart to examine the myths versus the realities of linear motion product customization:

MYTH	REALITY
Customization requires extensive end-to-end testing	Most customization involves simple modifications to standard products that have already been fully tested.
Slow delivery	With modern prototyping and tools, CAD drawings can be fed directly into production systems. Vendors can often deliver solutions within days.
High cost	While costs for systems that must be purpose designed from the ground up will be higher, most routine customizations add little or no incremental cost to the initial quote.
Violation of loyalty to existing suppliers	Selecting vendors in anticipation of potential customization needs avoids supplier relationship problems that may arise if your chosen supplier can't meet modification requirements that emerge later in the project lifecycle.



Online resources such as the round rail selector tool from Thomson Industries allow designers to make real-time changes, choose a material, add special machining (pictured), receive a quote and lead time immediately, and purchase their solution, thereby saving them costly time and keeping projects on track.



A Thomson virtual design consultation is a live, online engineering session where you create, customize, and optimize a compact linear motion system from scratch alongside a Thomson Linear expert.

Lowering the Price Point

Even if the business relationship begins with a customization need, it can sometimes be met inexpensively by mixing and matching standard components. For example, a supplier of CNC tubing and pipe bending systems sought help in designing a new machine to meet market demand for a scaled-down system. Their high-end system used two linear slides bolted together in a cross configuration to control motion on an XZ axis, using stepper motors to drive a 2-foot ball screw on each axis. The long length of the screw required support bearings on both ends and a special coupling to the stepper.

The first thing the linear motion component manufacturer did to reduce the cost was shorten the shaft to an 11-inch lead screw with a 6-inch drive, which eliminated the need for support at both ends. Specifying a stepper motor with an integrated motorized lead screw (MLS), reduced the need for external support further because the MLS motor bearings could support the load themselves. And because the lead screw and MLS rotor are combined into one part, there was no longer a need for external coupling of the screw and the rotor.

An Open Palette

These are but a few examples of customizations. The range of options is wide. You might customize stroke and extracted length down to millimeter scale; enhance control by adding encoders; comply with industry regulations by adding certification; select a more aesthetically pleasing finish; implement a custom adapter housing; or improve voltages or clutch handling. Even those are just mere examples of what could be customized on an electric actuator. This same degree of customization applies to shafting, screws, ball bushings, linear guides and a host of other linear motion components.

In these days, in which machine designers are having to do more, faster and with fewer people, the more uncertainty they can drive out of the process, the greater their chance of sustained success. Acknowledging the fact that the need to customize some projects is a likely possibility and taking a few minutes to be comfortable that you have partnered with a vendor that has deep customization capability can save you money and headaches down the road.

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Industrial Strength Reliability

SEW-Eurodrive gear units help power 42-mile conveyor system

Matthew Jaster, Director, Editorial Content

SEW-Eurodrive supplied 36 custom helical-bevel heavy industrial gear units engineered specifically for continuous-duty performance in rugged desert conditions. **(Image: SEW-Eurodrive)**

SEW-Eurodrive is helping power one of the most ambitious bulk material handling projects in North America through its contribution to the Dune Express conveyor system, a record-setting 42-mile single-flight conveyor designed to transport frac sand across the Permian Basin. Developed by Atlas Energy Solutions in collaboration with system integrator Voith Turbo, the Dune Express system is designed to move up to 13 million tons of frac sand annually from Kermit, Texas, to the New Mexico border.

The infrastructure-scale conveyor is expected to significantly reduce truck traffic, roadway congestion, fuel consumption, and associated emissions while improving logistics efficiency for wellsite operations.

"The Dune Express is a step change in oilfield logistics and will help redefine the efficiency and reliability for the Permian oil and gas community. In addition, the Dune Express will help make the communities of West Texas safer places to work and live by reducing truck traffic on public roads," said John Turner, president and CEO of Atlas Energy Solutions.

Environmental Demands

To support the extreme demands of the application, SEW-Eurodrive supplied 36 custom X.e Series helical-bevel heavy industrial gear units engineered specifically for continuous-duty performance in rugged desert conditions. The project required advanced thermal validation, high torque capacity, precision mechanical integration, and long-term reliability.

Digital data models and the latest calculation methods lay the foundations for a further improvement in the performance of Generation X.e helical-bevel gear units.

SEW-Eurodrive continuously factors the findings of field/test stand trials and simulations into its own calculations, thereby improving their accuracy and reliability. The mechanical and thermal design was precisely evaluated on this basis. In conjunction with the component optimizations already implemented in the past, this results in even higher thermal limit ratings, a much longer bearing service life, and higher nominal torques. Larger application angles are now permissible with the maximum overhung load.

One potential result of these optimizations for users is a smaller gear

Atlas Energy Expands Autonomous Truck Operations

Atlas Energy Solutions Inc. recently announced an expansion of its autonomous truck operations in the Permian Basin, advancing its commitment to unlocking energy by digitally transforming oilfield logistics.

Working with Kodiak AI, Inc. ("Kodiak") (Nasdaq: KDK), a leading provider of Physical AI-powered autonomous driving technology, Atlas is expanding its driverless proppant delivery program to a second simultaneous load-out point along its 42-mile Dune Express sand conveyor system. This additional load-out point expands the reach of autonomous deliveries and increases Atlas's responsiveness to growing customer demand.

In addition, Atlas and Kodiak have agreed to a delivery timetable that will expand Atlas's Kodiak-enabled fleet from 28 driverless trucks operating as of March 31, 2026, to 100 autonomous delivery trucks by mid-2027. The companies also expect to have the fleet operating on public roads by early 2027, subject to regulatory and operational milestones, dramatically expanding the reach of the Atlas autonomous fleet.

"This partnership with Kodiak is a critical part of the Atlas strategy to transform oilfield sand logistics through innovation," said Turner of Atlas Energy Solutions. "Our mission is to seek critical energy infrastructure with inefficiencies, then engineer solutions that improve efficiency, reduce risk and enhance our customers' operational success."

Atlas helps oil and gas producers overcome complex operational and technical challenges by providing high-quality proppant critical to well completions. By integrating mining and transportation automation with advanced last-mile logistics management, Atlas accelerates and simplifies access to critical oil and natural gas resources while reducing operational complexity, risk and cost.

Atlas is now concurrently operating driverless trucks at load-out sites located in Texas and New Mexico. Trucks equipped with the AI-enabled Kodiak Driver, Kodiak's autonomous driving system, now have expanded reach and service area to haul sand to well sites across the Permian, one of the world's most prolific oil and gas basins. Previously, Atlas's driverless trucks operated from one load-out point at a time. With autonomous operations now running from two distinct locations, approximately 90 minutes apart, Atlas can serve customers across a larger geographic area simultaneously.

Atlas's autonomous program has scaled steadily since its initial driverless deployments in 2024. As of March 31, 2026, Atlas operated 28 driverless trucks across 15 distinct routes, which together have carried approximately 7,000 loads and hauled more than 450,000 tons of sand. The fleet also completed over 23,500 driverless hours of operation in the first quarter of 2026. On July 20, Kodiak-powered trucks delivered 176 loads of sand in a single day, an all-time daily high across 18 months of driverless deployments with Atlas in the Permian Basin.

"Together, Atlas and Kodiak have deployed the world's largest fleet of driverless big-rig trucks," said Don Burnette, founder and CEO, Kodiak. "We've demonstrated that autonomous trucking is delivering meaningful results today. Our expanding partnership, which now covers two unique locations, is creating a blueprint for how autonomy can transform logistics by improving efficiency, increasing productivity, and delivering lasting value for customers at commercial scale."

Earlier this year, Kodiak and Atlas collaborated to introduce advanced capabilities making it possible for one autonomous truck to haul three connected trailers simultaneously. This milestone marks the first ever autonomous triple-trailer trucking operation, with a combined loaded weight of more than 135 tons. Kodiak and Atlas expect to operate Atlas trucks on public roads by 2027, dramatically expanding the reach of Atlas's autonomous fleet.

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Atlas is now concurrently operating driverless trucks at load-out sites located in Texas and New Mexico. **(Image: Atlas Energy Solutions)**

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The Dune Express conveyor belt is one-of-a-kind and is expected to significantly reduce traffic accidents and enhance the safety of public roads. **(Image: SEW-Eurodrive)**

unit size. Besides reducing the oil volume, energy consumption and total cost of ownership (TCO), this also means users' own designs are lighter and take up less space.

For drives subjected to high loads and mechanical safety concerns, the potential for damage prevention is improved. Additionally, a lower oil-bath temperature and a higher bearing service life mean less frequent maintenance during operation. These are vital when transporting material across one of the most demanding conveyor applications ever constructed.

"Engineering for a 42-mile conveyor takes more than horsepower. It takes understanding application dynamics, thermal performance, and logistics at scale," said Austin Burdette, project manager, heavy industrial gearing at SEW-Eurodrive. "Our X.e gear units and engineering teams delivered the reliability and performance required for a project of this magnitude."

SEW-Eurodrive engineers collaborated closely with Voith Turbo throughout the project to deliver the following:

- Gearbox sizing matched to application dynamics
- Thermal performance modeling and bearing life analysis
- Mechanical interface verification and fabrication support
- Integrated condition monitoring and safety specifications
- On-site commissioning and logistics support

Technical Advantage

The magnitude and complexity of the Dune Express project required significant technical work. As reported earlier in *PTE*, the multimillion-dollar project required different drive package designs for the install. Most significantly, the drives needed to be designed to provide a specified acceleration time of 10 minutes for the conveyors. This extended start-up time was required to maintain belt tensions, especially along the lengthy horizontal curves for two of the system's four belts. This start-up time is significantly longer than most large conveyors, which typically require 60 to 120 seconds.

During the planning phase, all companies involved had to be mindful of the 42-mile length of the system which included a world record single conveyor belt flight length of 16.4 miles without a mid-booster drive. The Dune Express conveyor belt is one-of-a-kind and is expected to significantly reduce traffic accidents and enhance the safety of public roads. The conveyor belt will also significantly reduce fuel emissions caused by transportation.

The conveyor system incorporates multiple SEW-Eurodrive X.e Series gear units ranging up to 900 horsepower and more than 1.46 million lbs.-in. of nominal output torque, highlighting the scale and technical sophistication of the installation.

Beyond the engineering achievement, the Dune Express represents a major evolution in bulk material transport infrastructure for the oil and gas industry. By replacing significant volumes of truck-based sand transportation with a continuous conveyor system, the project is expected to improve operational efficiency while reducing environmental and roadway impacts throughout the region.

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The Data-Driven Road Ahead

The role of AI in automotive applications

Matthew Jaster, Director, Editorial Content

AI has become an asset for the automotive industry today, offering transformative benefits that enhance efficiency, safety, and customer experience. With advancements in machine learning and data analytics, manufacturers can analyze vast amounts of data from various sources, including vehicle sensors, production lines, and consumer interactions. This enables real-time decision-making, optimizing everything from supply chain management to production processes, ultimately leading to reduced costs and improved operational efficiency.

I recently spoke with Farzaneh Tatari, senior control engineer, Drive System Design (DSD), to discuss the role of AI in powertrain technology. During our conversation, she highlighted several key areas where AI is currently being utilized in vehicles, including enhancements in manufacturing processes, improved sensor integration and innovations in engineering practices.

Greatest Impact

The areas where AI is having the greatest impact in automotive applications include autonomous driving, virtual sensor modeling and predictive maintenance. Tatari said DSD is using supervised machine learning for object detection. Essentially, the supervised machine learning algorithm receives camera frames from the vehicle camera and can detect what is in front of the vehicle or around the vehicle, whether it's another car, pedestrian, cyclist, dog, or cat, for example.

Reinforcement learning is being used in the control systems of autonomous vehicles, where the control software can tell a vehicle the best trajectory to do a maneuver and how to track that trajectory. So basically, reinforcement learning is nowadays being used for trajectory planning and trajectory tracking in autonomous vehicles.

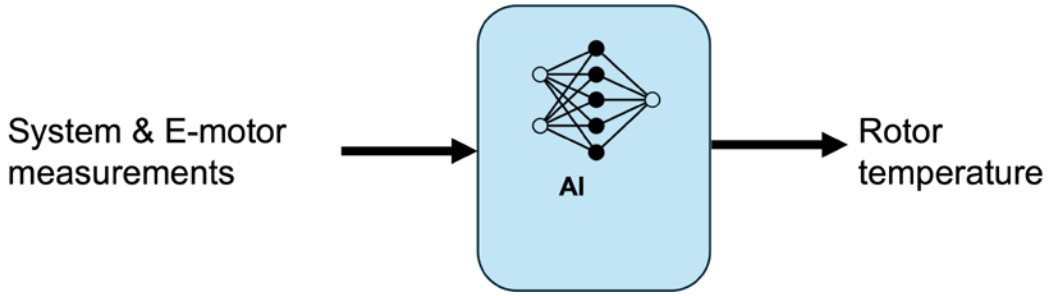
"Another popular area is virtual sensor modeling. In virtual sensor modeling, basically, we have a piece of software that's going to replace our physical sensor, and so we will be relying on estimating a quantity of interest based on the other measurements that are available in our system," Tatari said. "Data-driven virtual sensor modeling, or machine learning and deep learning-based virtual sensor modeling, are a big category for virtual sensors that rely on supervised machine learning methods to estimate those measurements instead of physically measuring them."

And then there's predictive maintenance where DSD can use fleet data from test vehicles to identify the wearing pattern of key components in the vehicle.

"We can estimate the remaining useful life of those key components. And if we know that in this many hours, or in this many miles that key component is going to fail, we can light up a service lamp for our driver and let him or her know that this component may be failing so they can take appropriate measures before these failures occur," she added.

Additional AI applications in automotive include intrusion detection and cybersecurity enhancement using machine learning. "We can identify the attacks over the Controller Area Network (CAN bus), over vehicle-to-vehicle connected systems, or vehicle-to-grid connections. If there is any failure or any attack over these networks that can be identified with supervised machine learning methods," Tatari said.

Tatari said virtual sensors are so important in leveraging this data because of the limitations physical sensors are imposing on the system. Sometimes it is impossible to install a physical sensor in a specific system, like installing a temperature sensor in the rotary part of the motor, for example.



Data-driven thermal models provide real time temperature estimations. **(Image: DSD)**

"These physical sensors degrade over time, and that can really degrade the performance of the entire system. Also, they can get noisy, they can get slow, and all in all, that can lead to inefficiencies across the entire system," Tatari said. "Some physical sensors are unmanufacturable because they're too complex and expensive. Data-driven virtual sensors are a type of virtual sensors that can bridge the gap. We can utilize the existing data, the test data, as well as the development data to reduce some of these physical sensors in production. This reduces the cost and maintains the accuracy while increasing the reliability and efficiency of the system."

Thermal Modeling

There are several methods for electric motor thermal modeling today including indirect methods, long-thermometer thermal networks, Kalman-based or observer-based methods, computational fluid dynamics, Finite Element Analysis (FEA) models, and data-driven or machine learning-based thermal models.

"The advantage of data-driven models is that they are very accurate because they can model the non-linearities or the higher-order terms, which cannot be captured with other methods. Data-driven thermal modeling can be executed fast for real-time temperature estimation while other methods like computational fluid dynamics or FEA cannot," Tatari said.

The biggest advantage of data-driven thermal models is generalization. Tatari said if DSD develops a data-driven or machine learning-based thermal model for a specific motor variant, that can be generalized to another motor variant. This is something which is not always applicable for the rest of the thermal modeling methods.

There are so many advantages with machine learning-based or data-driven thermal models, but of course the trade-off is having good data—enough data—to develop these models. Sometimes it is difficult to really understand what's going on inside the model due to the way the system interprets the data.

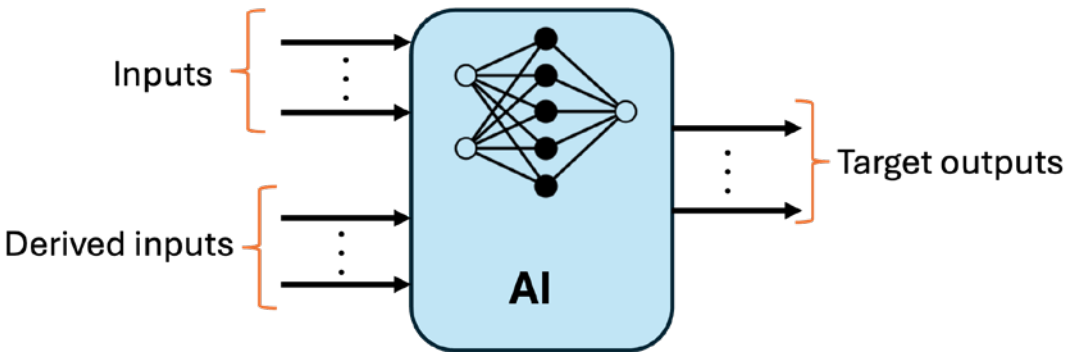
DSD is developing a thermal model for the motor with the basic intention to guarantee the safety of the motor. Tatari said that if they have a precise estimation of the motor temperature, they can guarantee motor safety and prevent high temperatures.

"At the same time, we can be less conservative with our thermal margins, so that by knowing an accurate estimation of the motor temperature, we can have more precise thermal limits and really know exactly when to derate and when not to derate. This can lead to increasing efficiency and the performance of the motor and the system that is working with that motor," she added.

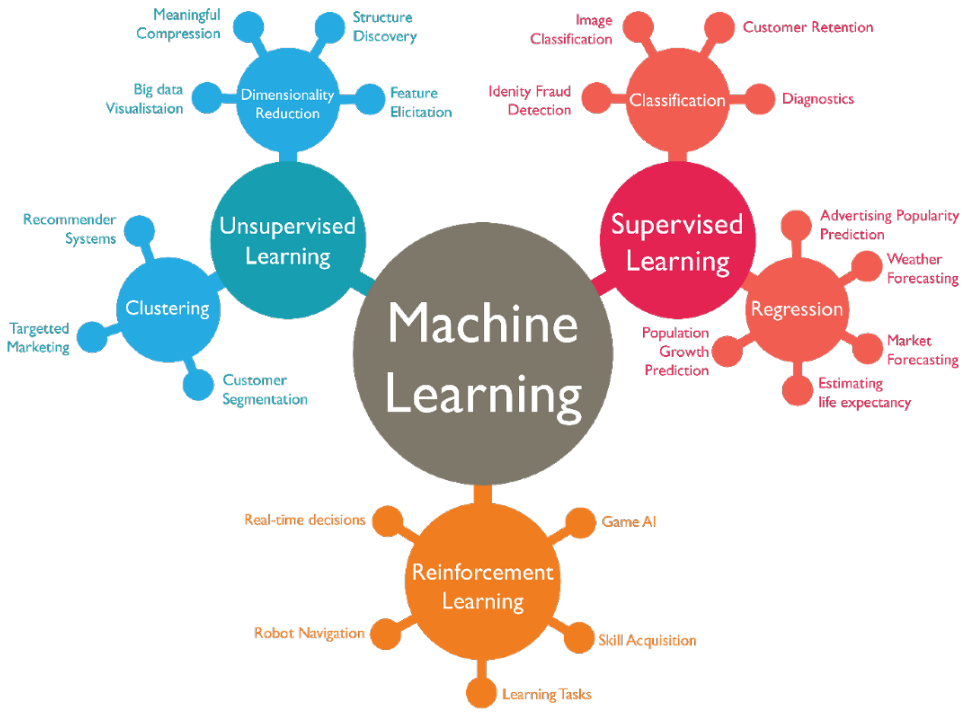
An Evolving AI Market

AI applications are evolving at a very fast rate. DSD has several methods and tools being developed with AI, according to Tatari.

"We will be moving toward physics-informed data-driven models, or physics-informed neural networks,



In artificial intelligence, inputs are the raw data or user prompts fed into a system, while derived inputs are secondary features, intermediate representations, or synthetic content generated by transforming those original materials. **(Image: DSD)**



Areas like machine learning, diagnostics and reinforcement learning are driving AI growth. **(Image: DSD)**

because we want to incorporate our physical/engineering knowledge to the information we can get from the data. Through integration we can have a better interpretability of our physics-informed data-driven models," she said.

For deploying these algorithms into production, Tatari sees a path where they'll be moving from machine learning algorithms and AI-based algorithms and deploying them in the cloud. DSD is already moving toward deploying them in edge devices—in local ECUs— reducing the inference latency time for executing an algorithm in the cloud.

For production timelines, AI can really help to decrease the time for making a production or product ready for production. By having all these AI-based digital twins that are high-fidelity models, DSD can speed up development especially in hardware-in-the-loop testing, relying on these models to be fast for prototyping and developing the software of the vehicle faster.

"AI used to change processes every six months, now it feels like monumental changes are taking place every week, every day," Tatari said. Although DSD's AI journey started years ago, the organization is focused on increasing the quality of its engineering services.

"We don't want to use AI just to automate away engineering. We want to leverage AI to increase the quality of our engineering services. And you know that here at DSD, we are focusing on the areas of control system software development, electric machine design, and power electronic design, advanced mechanical systems design, and these are the areas that having deep technical knowledge and wide engineering domain knowledge is essential," Tatari said. "But we would like to leverage AI in these areas to increase the quality of our engineering services and at the same time increase the speed of our deliverables for our clients."

Safety, innovation, and predictive and prescriptive maintenance will drive AI's growth in the automotive industry in the coming years. Advanced driver-assistance systems (ADAS) powered by AI can process data from cameras, radar, and lidar to provide features like automatic braking, lane-keeping assistance, and collision avoidance. As these systems become more sophisticated, they contribute to a marked decrease in accidents and fatalities on the road, fostering greater consumer trust in autonomous and semi-autonomous vehicles. Moreover, AI can predict maintenance needs by analyzing vehicle performance data, thereby reducing the likelihood of breakdowns and enhancing the components and systems that make up the vehicle.

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Vibration Analysis for Fault Diagnosis of Cycloidal Gearbox Using Wavelet Transform

Sandeep V. Thube

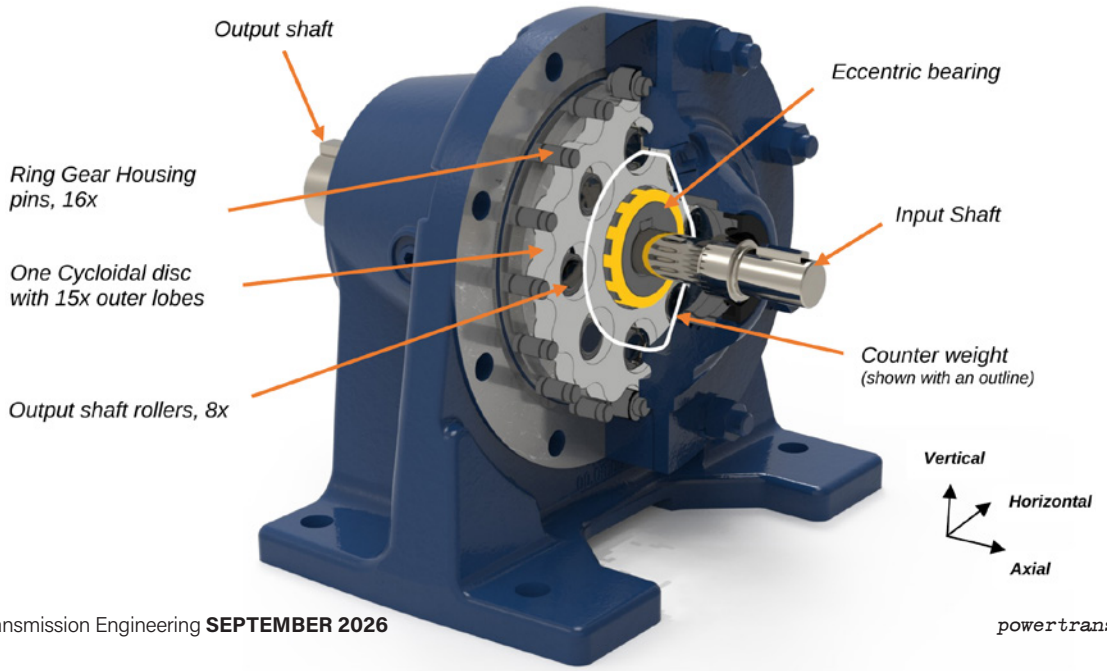
Nomenclature

FFT	Fast Fourier Transform
WT	Wavelet Transform
$X(t)$	Signal to be analyzed, in 1d
$\psi_0(t)$	Mother wavelet
j	Scale of Wavelet Transform
k	Position in time shift
$D_x(j, k)$	Discrete wavelet transform coefficient
H	Hurst or self-similar parameter
h	Hölder exponent
$\zeta(q)$	The scaling function of Multifractal analysis
c_1, c_2	Cumulants, to quantify the strength of the multifractality. If c_2=0, the process is monofractal; otherwise, multifractal.
$S_q(j)$	Structure function: it represents the qth moment of the wavelet leaders at each scale j
$D(h)$	Multifractal spectrum OR Singularity spectrum
$L(j, k)$	Wavelet leaders at scale j and position k
q	Moment
N	Number of wavelet leaders available at scale 2^j
CPM	Cycle per minute

Introduction

For years, the cycloidal reducer (Figure 1) has proven its performance in a variety of applications, from robotics to wastewater treatment. Along with involute gearing, the cycloidal mechanism has its place in the mechanical power transmission world. It is well known for its high torque density, high integer ratio per stage, and shock load handling capabilities. Its *poke-yoke* assembly refrains from introducing any errors during assembly and allows the unit to operate with low maintenance. Despite these advantages, the reducer may have a variable angular speed at its output shaft, in large part due to manufacturing imperfections. A constant transmission ratio during gear meshing can be attained with involute gearing by following standardized methods established in the gearing industry (Ref. 1). Considering the manufacturing deviations and loading conditions, one could optimize the macro and micro geometries of the involute gearing and get a fairly controlled transmission error. In the case of cycloidal gearing, however, the same may not hold. The steadiness of the ratio, or the output shaft's angular velocity, will vary with the cycloidal gearbox manufacturer. Small dimensional deviations in rotating components, such as the cycloidal disc and rollers, will influence the variations in the output shaft rotation. The torque load on the output shaft also induces the variation. Such scenarios have the potential to negatively influence traditional vibration-based fault diagnosis methods.

Figure 1—Cross-section of the cycloidal reducer used for vibration data collection (FFT and wavelet analysis), with probe axes (vertical, horizontal, axial) labeled at right.



Vibration analysis has long been sought for condition monitoring and fault diagnosis of rotating equipment or machinery. Conventional methods utilize analyzing the time spectrum and frequency spectrum with fast Fourier transform (FFT), or in many instances both. The raw vibration data or signal recorded by the accelerometer generates the time spectrum with no additional signal processing. The time waveform is useful in identifying modulation and pulses in the signal. When frequencies of the rotary components in the gearbox are known, the same signal can be processed with FFT to obtain the frequency spectrum and then locate high-energy generating or out-of-sync components. The wide acceptance of FFT hinges on the assumption that the processed signal is stationary, meaning all the frequencies in the signal exist in all instances, and they do not vary with time. The stationary signal, hence, does not depend on the data sampling period or recording instances (Ref. 2). This assumption fails when the angular speed of the gearbox shafts fluctuates due to transmission error and load fluctuations, and the signal becomes non-stationary, or time-dependent.

It is worth mentioning that the involute and cycloidal gearing differ in their primary failure modes. In involute gearing, the common failure is tooth breakage. In (epi) cycloidal gearing, as the cycloidal disc lobes (equivalent to the gear teeth) experience less shear force with a much higher contact ratio, they tend to break less. The common maintenance issues for a cycloidal gearbox would be a worn-out cycloidal disc, eccentric bearing, or damage to the ring gear housing pins. Therefore, the conventional way of fault diagnosis may not effectively capture such subtle changes.

The FFT-processed signal has no time (or phase) related information in it. The nonstationary signal raises a need to know when an event has taken place on a timeline, along with its appearance on the frequency scale. Analyzing the separate graphs of time and frequency side-by-side may not be intuitive. If one tries to put time and frequency on one graph, it is well known that Heisenberg's Uncertainty Principle would allow resolution of the signal for one of the components (time or frequency), but not both. To overcome this limitation, various time-frequency analysis methods were developed by sacrificing some resolution in both components. Among those methods are the short-time Fourier transform, Wigner-Ville Distribution, and wavelet transform (WT) (Ref. 3). Typical graphs of FFT and WT are shown in Figure 2 for comparison purposes. Each line in the FFT graph represents a frequency with a certain amplitude, whereas in the WT Scalogram, the brightness of each band signifies the strength of the frequency component in a specific frequency range seen on the *Y*-axis, at a certain time.

Since its introduction in 1982, the WT method has gained more interest in vibration measurements (Ref. 4). The French word *wavelet* means a "small wave." In WT signal analysis, a wavelet function (or a predetermined signal) is blended with the signal to be analyzed using convolution to extract necessary information. This information about the signal could capture singular events that the Fourier Transform treats as anomalies and ignores. For instance, an event of *tooth loss* of the involute gear appears as a singularity in the time spectrum, but it is hard to capture in the frequency spectrum. In the frequency spectrum, it shows up in sidebands to the gear mesh frequency. The sideband, however, truly attributes to the frequency or amplitude modulation and not necessarily to the defect. In other instances, the singularities are buried in the vibration data and impossible to identify in any of the above-mentioned spectra. These events or singularities are also defined as fractal features. The term *fractal* was coined to denote geometries and patterns that could not be defined with Euclidean geometry (Ref. 5). The simplest way to comprehend fractals is with Taylor series. A function $f(t)$ is approximated around a certain time t_i as below:

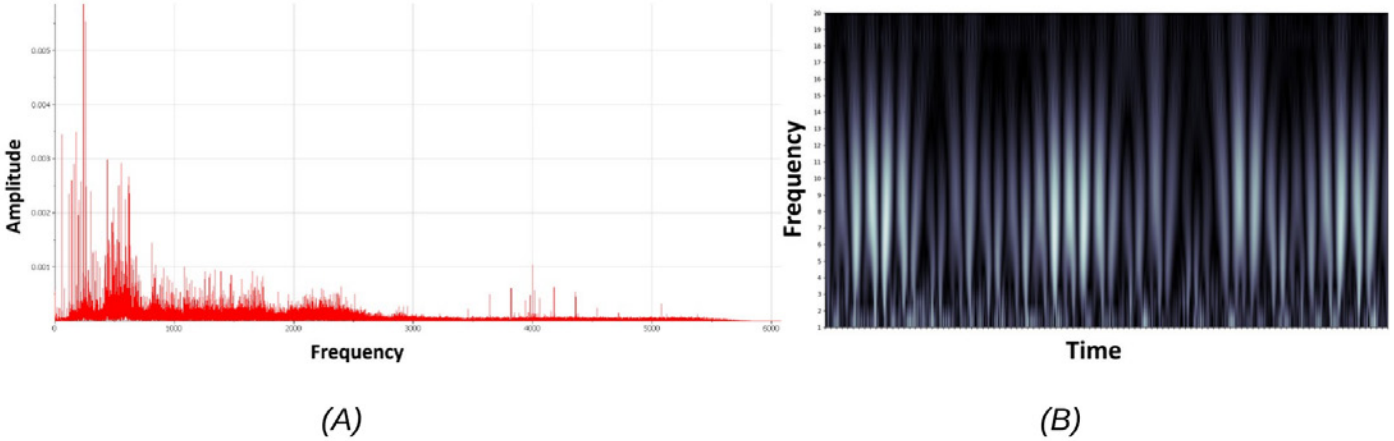


Figure 2—(A) A typical Frequency spectrum obtained from Fast Fourier Transform, (B) A typical Scalogram derived from Continuous Wavelet Transform (WT).

$$f(t) = a_0 + a_1(t - t_i) + a_1(t - t_i)^2 + \cdots + a_h(t - t_i)^{p_i} \quad (1)$$

where p_i is a non-integer number quantifying the local singularity of the function $f(t)$ at $t=t_i$, with a_h coefficient. Here, the non-integer exponent is referred to as a singularity exponent, and due to this exponent, the function approximates the singular behavior, which would be ignored when an integer exponent is used.

Another important aspect of WT is that it generates coefficients that are associated with the singularities embedded in the signal. The signal could be a monofractal, i.e., having a single coefficient to represent all singularities, or multifractal. The popular applications of multifractal analysis are modeling turbulent flow of gases, stock markets, image processing, and filtering heartbeat signals to display on an electrocardiogram or ECG (Refs. 6,7,8).

In this paper, WT will be used to detect fractals embedded in the vibration data to demonstrate its benefit in distinguishing a cycloidal reducer fault, which otherwise would go undetected.

Literature Review

Multiple research papers have demonstrated the use of WT-based multifractal analysis to diagnose faults in rotary machinery. In the case of ball bearings, when multiple faults with different diameters and depths are present on both inner and outer races, the time/ frequency spectrum could distinguish a very few of them (Ref. 9). The paper focuses on comparing a variety of induced faults in ball bearings using the WT modulus maxima method. It shows that different fault conditions would carry the fault information in the form of a distribution of singularities. The multifractal spectrum and scaling exponents can be clearly distinguished.

One interesting application of multifractal analysis is in material testing. To identify progression of the failure in a structural composite material, the multifractal spectrum and fractal leaders could be deployed to observe nonstationary changes in the vibration signal (Ref. 10). In this experiment, vibratory signals generated during a composite bending test were recorded. The test progressed in three stages until the failure of the specimen. Each stage generated fractals that were plotted on a singularity spectrum to differentiate from each other. The holder coefficients increase with increased bending and thus would help to indicate the initial or final stage of the failure.

The gear fault analyses were performed on spur gear pairs to demonstrate the use of WT (Refs. 11,12). For these analyses, multiple gear pairs showing different stages of the bending fatigue failure progression were mounted on test rigs, and vibration samples were analyzed. For instance, Ref. 11 shows how the distribution of the scaling exponents changes from a healthy gear with no cracks to the fatigue crack magnitude of 15 percent, 50 percent, and 75 percent of the gear tooth root, and subsequently relates to tooth loss. Such progression of the failure would not be easy to distinguish by observing FFT and the power spectral density graphs. These studies deploy fault detection algorithms to perform gear diagnostics. Along with gear fault diagnosis, the WT method has also been used to simulate gear misalignment due to assembly error and variation in clearance (Ref. 13). These faults, when recorded in separate tests and plotted on the multifractal spectra, show differences in the singularity distributions. Singularity subsets, called cumulants, were fed to machine learning methods, such as neural network (NN), K-NN, and support vector machine (SVM), to classify the gearbox state.

In the case of Cycloidal gearbox fault diagnosis, the benefits of the WT are demonstrated by comparing the vibration data gathered from the faulty and non-faulty Cyclo reducers (Ref. 14). The paper argues that the conventional FFT falls short in distinguishing these two reducers. To create a fault in the gearbox, two rotary components, in this case ring gear housing pins, were removed (refer to Figure 1). Plots of multifractal spectra and two-cumulant dispersions show clear separations of faulty and non-faulty data. The removal of the components may represent an assembly error. However, it does not specifically depict flaws such as component fracture, wear, or manufacturing error (clearance due to inadequate tolerance). Another paper on cycloidal fault diagnosis uses actual worn-out parts, including the disc and eccentric bearing, but only considers FFT in vibration analysis (Ref. 15). The current paper intends to extend the aforementioned analyses and perform WT multifractal analysis on a simulated worn-out cycloidal disc.

The objective of this paper is to diagnose a cycloidal gearbox by utilizing discrete wavelet transform analysis and compare the findings with FFT.

Wavelet Transform Multifractal Analysis

A signal $X(t)$ in 1d can be decomposed with WT by using a known function or *mother wavelet*, $\psi_0(t)$, into scales that correspond to frequencies. When plotted against the time shift on the X-axis, a time-frequency graph can be achieved (refer to Figure 2B). In this work, discrete wavelet transform (DWT) is utilized as it is computationally more efficient than continuous wavelet transform (CWT). The DWT coefficients are defined as:

$$D_x(j,k) = \int X(t)\, 2^{-\frac{j}{2}} \psi_0(2^j t - k)\, dt \quad (2)$$

The coefficients are then further used to derive Wavelet Leaders $L(j,k)$ in the multifractal analysis, as they are the largest coefficients in a certain time neighborhood (local supremum) and possess significant qualities to construct a multifractal formalism (Ref. 16). This can be elaborated by defining dyadic intervals:

$$\lambda_{j,k} = [k.2^j, (k+1)2^j] \quad (3)$$

So, the wavelet leaders are defined as:

$$L(j,k) = \sup_{\lambda' \subset 3\lambda} |d_{x,\lambda'}| \quad (4)$$

Wavelet leaders multifractal formalism (WLMF) in plotting the multifractal spectrum and log cumulants. The structure function derived from the wavelet leaders is defined as:

$$S_q(j) = \frac{1}{N}\sum_k |L(j,k)|^q \quad (5)$$

The scaling function $\zeta(q)$

$$\zeta(q) = c_1 q + \frac{c_2}{2}q^2 + \frac{c_3}{3}q^3 + \cdots \quad (5)$$

Here, when the cumulant c_2=0, the signal is monofractal and has the same scaling in entire data. when $c_2 \neq 0$, the signal is multifractal. The structure function follows a power-law scaling over scales

$$S_q(j) \propto 2^{\zeta(q)j} \quad (7)$$

The local regularities are described by Hölder exponent h, and the multifractal spectrum $D(h)$ represents the distribution of singularities in the signal.

$$D(h) = \inf_{q \neq 0} (1 + qh - \zeta_L(q)) \quad (8)$$

Experimentation with Cycloidal Gearbox

The vibration measurements were carried out on a test stand shown in Figure 3. A Sumitomo cycloidal gearbox of a 15.00:1 ratio was selected for the experiment. CNH-609 gearbox was specifically chosen as it consists of one cycloidal disc (Ref. 17). In lieu of the second disc, which exists in a typical cycloidal reducer, this gearbox design uses a counterweight to achieve dynamic balancing (refer to Figure 1). The one-disc mechanism simplifies the analysis and allows focusing on certain frequencies. In the setup, the gearbox was driven by a DC Servo motor with an encoder feedback loop to provide a consistent speed of 1,800 rpm (30 Hz). The DC motor's torque capacity was 2.39 Nm. The output shaft of the gearbox was connected to the asynchronous motor that acted as a brake. The torque and speed were measured using torque meters and encoders, respectively, for both input and output shafts. Three vibration sensors (sensitivity 87 mV/g at 6000 CPM) were mounted on the gearbox to collect tri-axial vibration data. All measurements were recorded using the National Instruments Data Acquisition (NI DAQ) system at a sample rate of 12.8 kHz for vibration and 10 kHz for torque measurements. For the input shaft spinning at 30 Hz, the DAQ system would generate 426 and 333 data points for vibration and torque, respectively, in one revolution of the shaft.

The gearbox was assembled with the standard lubricant using an NGLI 00 grade grease, with a predefined quantity. To confirm that all test iterations were performed at a steady temperature, the test stand was placed in a climate-controlled room with an ambient temperature of 21°C. Two temperature probes were placed to monitor the reduction housing or 'ring gear' housing of the gearbox. The load on the reducer output shaft was varied from 0 Nm to 15 Nm during the experimentation. The gearbox was tested for a healthy condition, meaning it had no induced errors. Then it was tested for a worn-out cycloidal disc or damaged condition by swapping out the normal disc with the one seen in Figure 4. Other than the disc, the use of the same parts in both conditions ensured that there were no other changes to influence the vibration data. It is important to highlight the fact that the induced change in the 'damaged' condition is relatively small. The goal of the testing was to gather vibration data and analyze it with FFT and multifractal analyses.

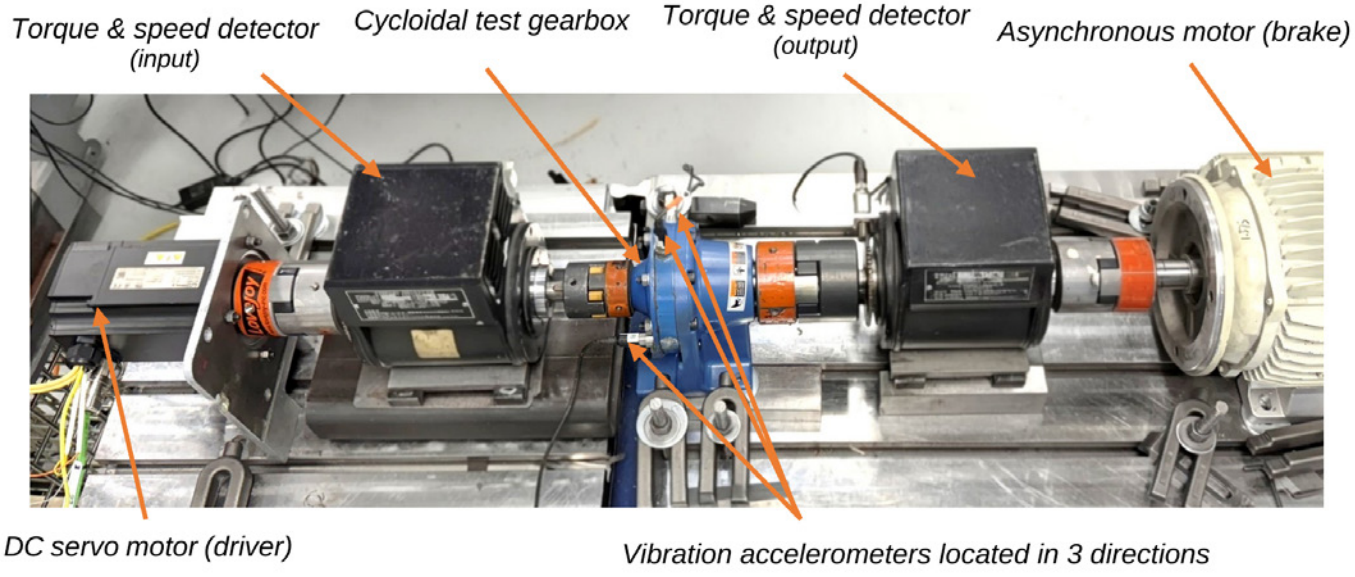


Figure 3—Cycloidal gearbox vibration measurement setup.

Referring to Figure 1, the cycloidal reducer utilized for the experiment has a cycloidal disc with 15 lobes. These lobes engage with 16 ring gear housing pins when the eccentric bearing sways the disc with its eccentricity. The 'engaged' disc (with pins) then generates a rotary motion while it is swaying and forces the output shaft to spin with the reduced speed in the opposite direction. The connection between the disc and the output shaft is achieved by engaging 8 output rollers within the 8 holes of the disc. This information helps to determine the mesh frequencies. The disc-pin mesh frequency is 16x order. The disc-output shaft roller mesh frequency is 16x8 = 128x order.

Results and Discussion

Figure 5 and Figure 7 show the torque and speed curves for healthy and damaged gearbox conditions. Each condition has 0 Nm and 15 Nm loads. Both torque and speed curves depict the steadiness of the power (proportional to the product of torque and speed) flowing through the system by generally showing opposite trends to each other. The variation in those curves over the period of three seconds confirms the randomness of the signal, hence categorizing it as a nonstationary signal. The FFT would assume the same signal as stationary, i.e., the signal not varying with time. This assumption ignores the local irregularity or fractals, and hence potentially any evidence of the fault existence. When the signal of one second period was FFT processed and plotted against the RMS amplitude in m/s^2 (refer to Figures 6 and 8), the aforementioned cycloidal mesh frequencies can be observed.

A typical way to diagnose any faulty machine using vibration is to compare its pre- and post-incident data, which means comparing the healthy (Figure 6) and the damaged reducer (Figure 8) graphs. However, apart from observing the higher amplitudes across the spectrum, it was incomprehensible to establish any relation with the fault by utilizing known frequencies (highlighted in graphs). Even at 16× order (disc-pin mesh frequency), where the fault was induced, no noticeable relative data change was observed. The same time period (one second) vibration data was then analyzed with WT, by plotting the Scalogram shown in Figure 9. As discussed in the "Introduction" section, the Scalogram or "Frequency vs Time" graph generally reveals the dominant frequencies at a time instant inside the non-stationary signal. Figure 9 shows a burst in localized activities, confirming the existence of mono- or multifractality in the signal generated by the damaged gearbox. Equations 4–8 were used to perform Multifractal analysis to extract wavelet coefficients that built the Scalogram, to derive the multifractal spectrum. The multifractal spectrum is plotted in Figure 10 for all three axes of vibrations: vertical, horizontal, and axial. The axis diagram, referred to in Figure 1, has the reducer shaft axis aligned with the vibration axial direction, and the remaining axes are in the radial direction of the cycloidal disc.

Figure 4—"Damaged" cycloidal disc with a simulated worn-out lobe (highlighted). This was achieved by removing material from the lobe flank and increasing the surface roughness.

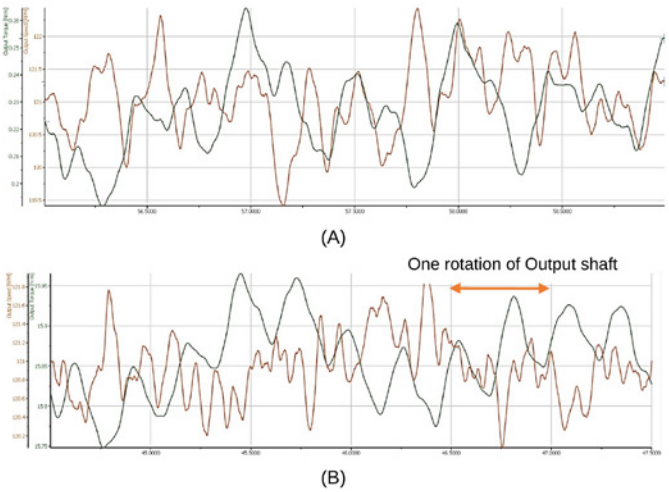


Figure 5—Healthy reducer: Output Torque and Speed curves at (A) zero load and (B) 15 Nm load, over three seconds.

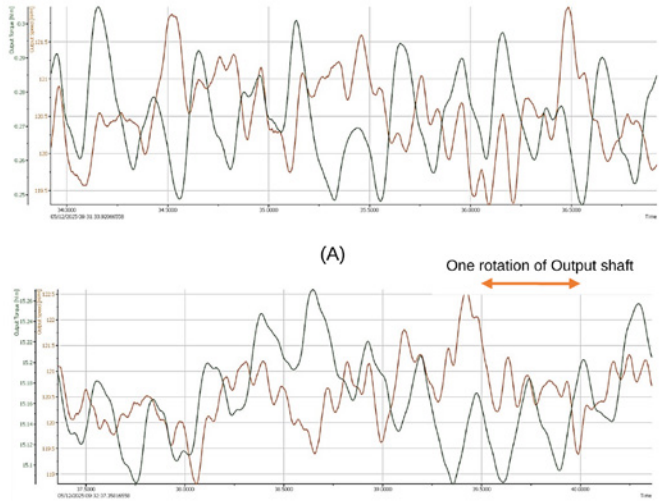


Figure 7—Damaged reducer: Output Torque and Speed curves at (A) zero load and (B) 15 Nm load, over three seconds.

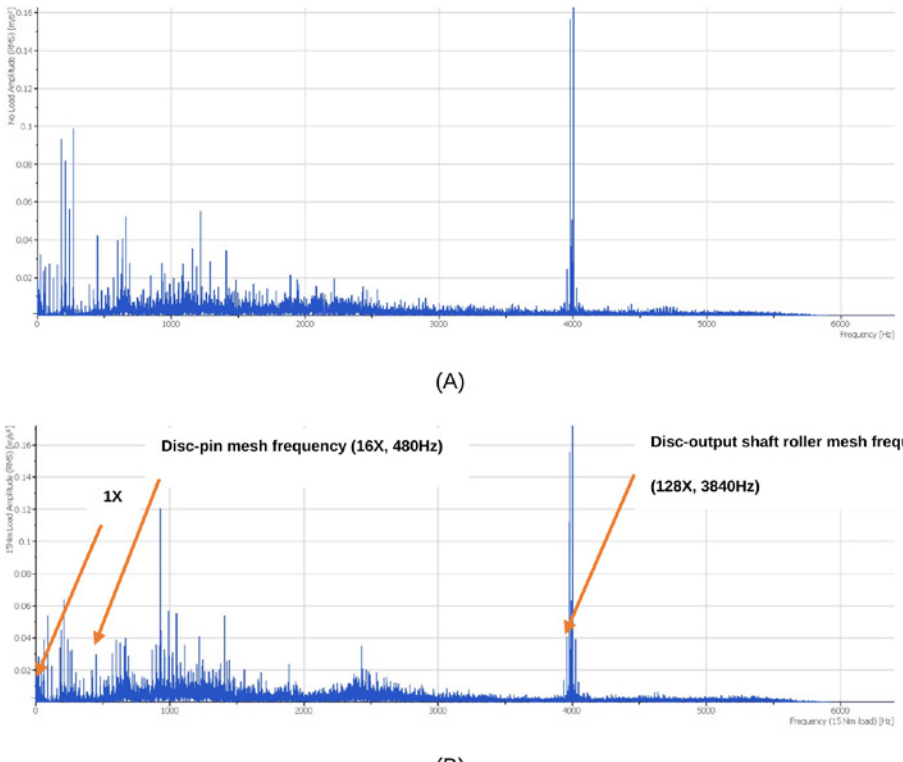


Figure 6—Healthy reducer: Fast Fourier Transform at (A) zero load and (B) 15 Nm load, data shown for the "vertical" axis.

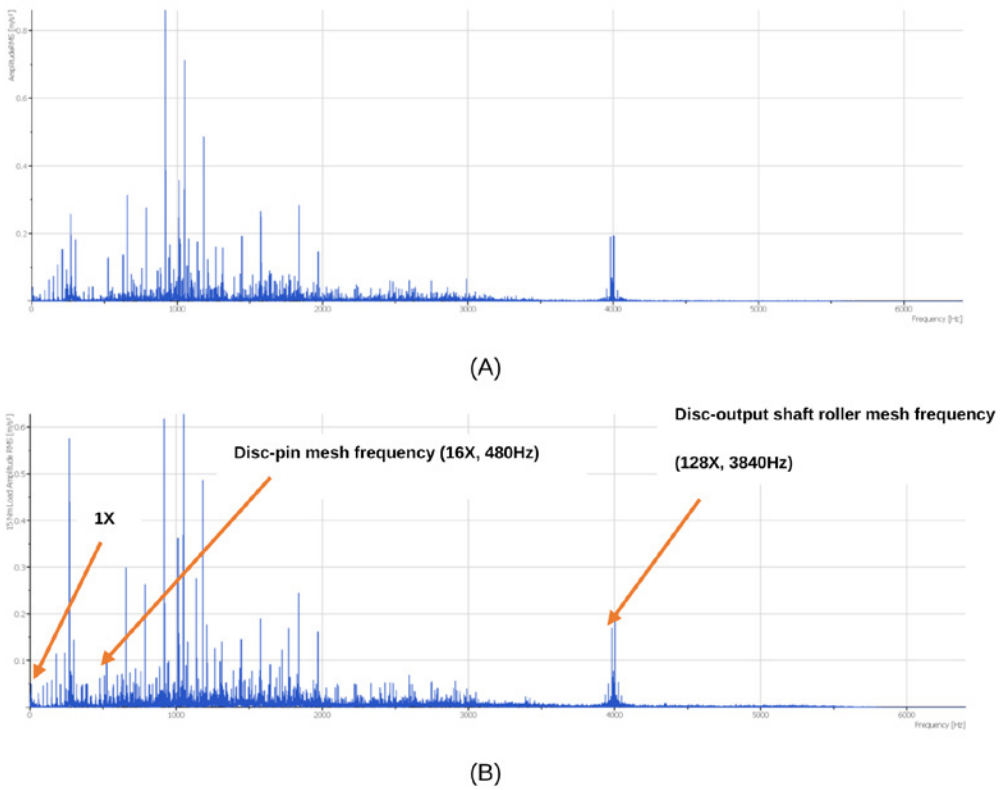


Figure 8—Damaged reducer: Fast Fourier Transform at (A) zero load and (B) 15 Nm load data shown for the "vertical" axis.

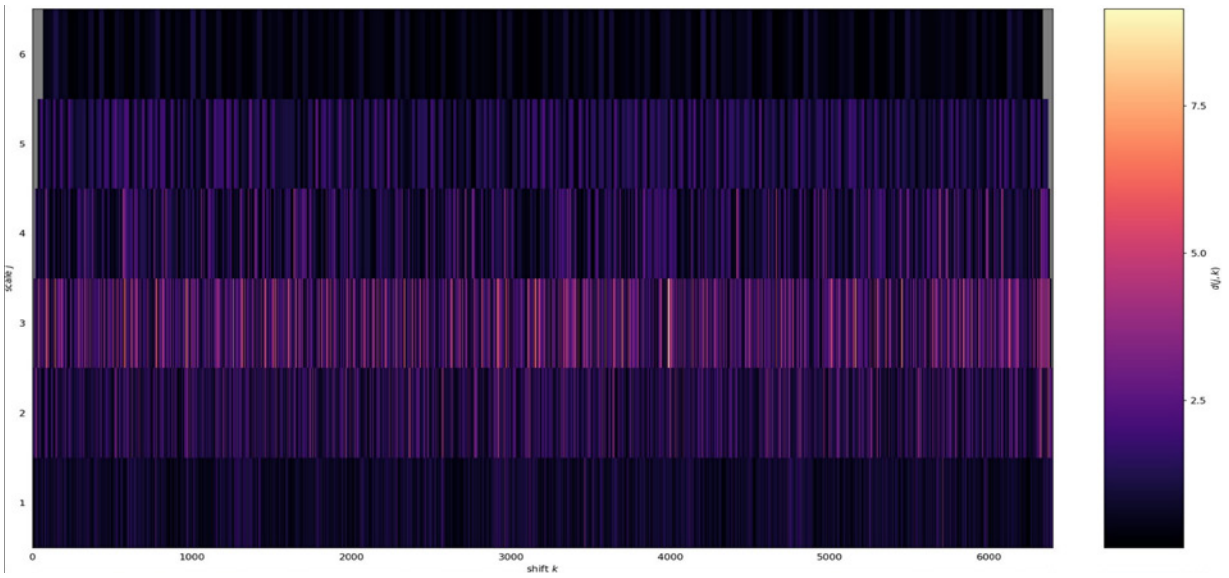


Figure 9—DWT Scalogram for damaged gearbox in vertical direction over 1 second time period, under 15 Nm load. Shift **k** *on the* **X***-axis represents the time, and scale* **j** *on the* **Y***-axis corresponds to the frequency. The higher the value of* **j**, *the lower the frequency. The color change shows variation in the magnitude of wavelet coefficients. The lighter color indicates stronger local fluctuations.*

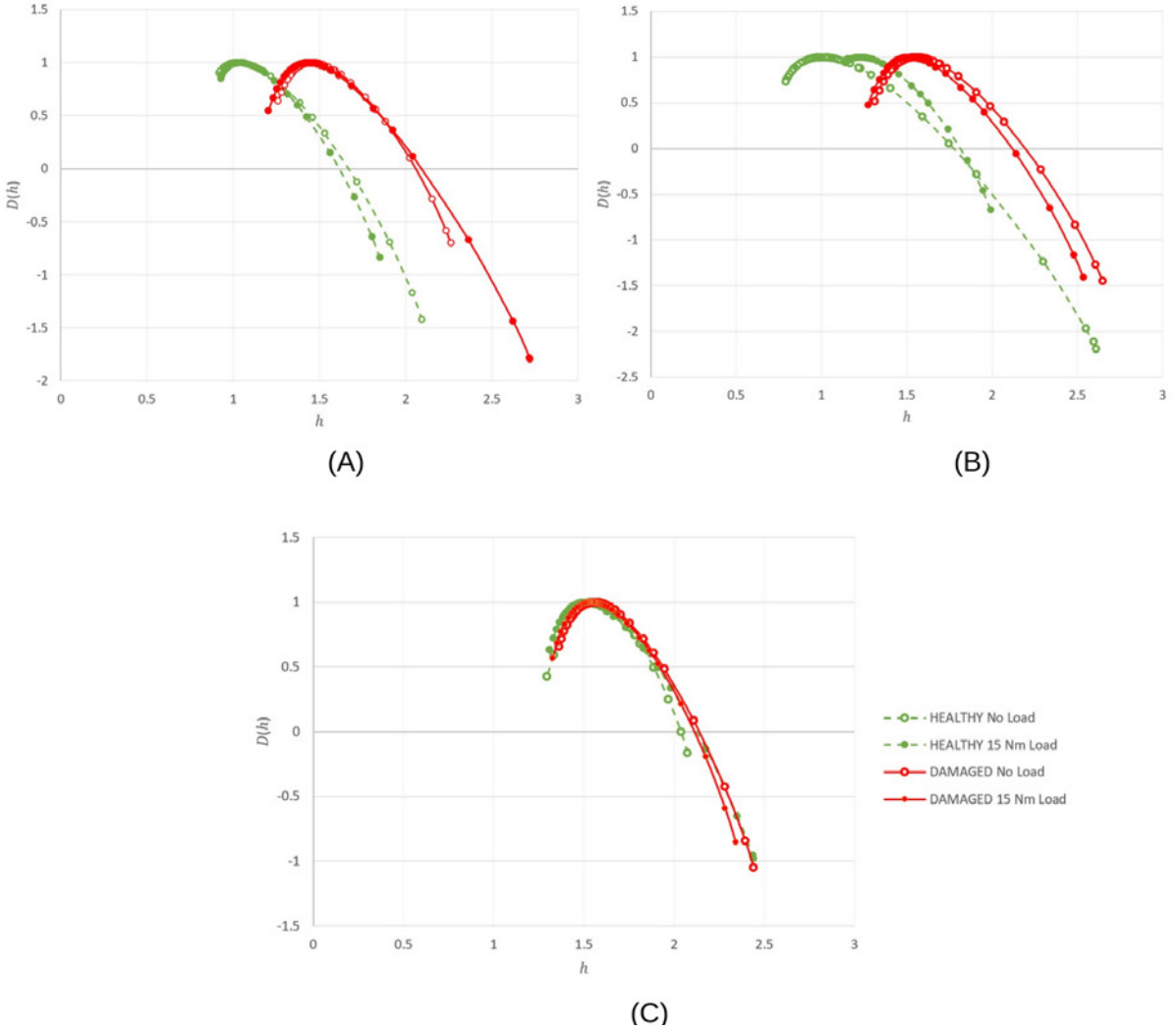


Figure 10—Multifractal spectra for healthy and damaged conditions measured in (A) vertical, (B) horizontal, and (C) axial directions. The multifractal spectrum **D(h)** *is plotted against* **h**, *the Hölder exponent.*

Each graph in Figure 10 consists of four curves showing different operating conditions of the gearbox: a healthy reducer with no load, a healthy reducer with 15 Nm load, a damaged reducer with no load, and a damaged reducer with 15 Nm load. Based on their positioning on the graph, the curves can visibly be sorted into healthy and damaged groups (green color and red color, respectively) in Figure 10(A) and Figure 10(B). The damaged gearbox's curves are shifted towards the right side of the multifractal spectrum, making them separated from the healthy ones. It can be argued that the main cause of this distinction was the induced damage on the cycloidal disc. The worn-out surface on the disc generated singularities affecting the wavelet coefficients, subsequently creating a deviation in the multifractal spectrum in radial directions. The axial axis graph, Figure 10(C), does not show similar shifting, as the worn-out lobe of the disc would not have energy change in this direction. The loading conditions, 0 Nm and 15 Nm, do not noticeably influence the shifting in all three graphs.

Conclusion

The paper compares results of the two tests conducted on the same gearbox. The only difference between the two test setups was the condition of Cycloidal disc, depicting 'healthy' in one and 'faulty' in another. The multifractal spectrum clearly distinguished the vibration data with respect to their conditions, which Fast Fourier Transform graphs could not. This paper argues that the wavelet transform based multifractal analysis approach makes the Cycloidal gearbox diagnosis less ambiguous compared to FFT. This is mainly because the collected vibration signals were time dependent and the singularities in the signal cannot be captured using FFT. The multifractal spectra also showed that the load on the gearbox output shaft does not significantly influence the curve shifting or the Hölder coefficient. For the future work, it is worth exploring the 'worn-out' effect of other Cycloidal gearbox components, such ring gear pins, output rollers, on the multifractal spectrum and establish the changes to be utilized in fault diagnostics.

PTE

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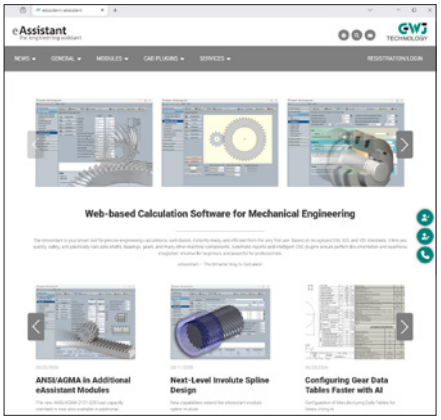
GWJ TECHNOLOGY

Launches New Websites for *eAssistant*, *TBK* and GWJ



GWJ Technology GmbH has launched completely redesigned websites for its *eAssistant* and *TBK* brands, as well as its corporate website. With this relaunch, the company introduces a modern, user-friendly design and optimized content that makes it easier than ever to access technical information and engineering software solutions. The new websites focus on intuitive navigation and a clear information structure, enabling users to quickly find the content they need. Particular emphasis has been placed on organizing technical information in a logical and accessible way, helping both newcomers and experienced engineers efficiently locate relevant data, calculation methods, and software features.

The website for *eAssistant*, GWJ's web-based engineering calculation software, has been extensively redesigned. It now provides a concise and well-structured overview of its capabilities for the design and verification of classic machine elements, including gears, shafts, bearings, and bolted joints. The new presentation highlights the software's web-based functionality, calculation modules, and integration with leading 3D CAD systems, making its benefits for engineering design and product development even more transparent. *TBK*, a well-established engineering calculation software solution with decades of industry experience, supports engineers in the design and verification of machine elements and mechanical components. Its new website offers a clear overview of the software's features, application areas, and practical use cases, enabling visitors to quickly understand its capabilities.

The corporate website of GWJ Technology has also been comprehensively modernized. It provides a compact overview of the company's portfolio, recent developments, and its position as an innovative partner for engineering software solutions. All three websites have been developed using responsive design principles, ensuring an optimal user experience across desktop computers, tablets, and smartphones. Content automatically adapts to different screen sizes, providing consistent usability and accessibility on every device. The new websites are now available and are intended for engineers, designers, and existing and prospective customers seeking engineering calculation software and technical information for machine element design.

gwj.de

THOMSON

Supports Elara Aerospace in Record-Seeking Rocket Launch Mission

Regal Rexnord linear motion solutions brand, Thomson, is supporting Elara Aerospace, an academically led initiative founded at the Technical University of Munich (TUM), with precision linear motion technology for its liquid-fueled Methalox rocket.

The Elara team is seeking to become the first student group worldwide to develop a liquid-propelled rocket capable of exceeding 100 kilometers in altitude while being fully reusable and have space for up to 100 kg of scientific experiments. As part of a joint partnership with sister brands Boston Gear and Kollmorgen, Thomson is providing key actuation components that will support active engine positioning and critical flight control functions.

The system will use two Thomson PC Series precision linear actuators integrated with Kollmorgen AKM13D servo motors and dual-axis drive systems, along with Boston Gear Micron NemaTRUE planetary gearheads. Together, the components form a coordinated motion solution tailored to the application's performance requirements. In the Elara rocket, the actuators will support engine gimbaling, enabling controlled movement within a narrow ±5 degree operating range. The PC Series actuators were selected for their compact design, ball screw based construction and ability to deliver accurate, repeatable motion in space constrained applications.

"Rocket control applications leave very little room for uncertainty. Every commanded movement must be predictable, measurable and easy to verify," said Anders Karlsson, business development manager for Regal Rexnord's Linear Motion Division. "For us, the value of this partnership is not only in supplying components but in helping Elara build confidence in the actuation approach before the system moves into flight use. Working closely with the team helped us ensure the motion package fits cleanly within the overall engine control architecture."

The actuators were supplied as individual components, giving the Elara Aerospace team flexibility in system design and testing. The motion system is currently being validated on development platforms for use in the rocket's engine control system.

"For an academically led team working on active engine control, it was important for us to use components

that were not only technically capable but also practical to work with," said Tom Luca Reinhardt, founder and CEO of Elara Aerospace. "Thomson's guidance gave us a clear path for the thrust vector control design without adding unnecessary complexity."

thomsonlinear.com/en/products/precision-linear-actuators/pc-series

REM SURFACE ENGINEERING

Celebrates 20-Year Milestone for President & CEO Justin Michaud

REM Surface Engineering is proud to celebrate the 20th work anniversary of its President and CEO, Justin Michaud. Over the past two decades, Michaud has been the driving force behind the company's technological evolution, expansion into cutting-edge industrial sectors, and a significant broadening of its global footprint.

Michaud joined the family-owned enterprise in 2006, continuing a legacy of innovation started by his grandfather, Robert Michaud, in 1965. Beginning his career as corporate special projects manager, Justin rapidly assumed increasing leadership responsibilities. He served as director of operations starting in 2009 and as vice president in 2012, before being officially appointed as CEO and president in 2017.

Throughout his 20-year tenure, Michaud has worked across every business segment of the REM organization. Under his guidance, the company has transformed its application portfolio, driving critical surface finishing advancements in metal Additive Manufacturing (AM), aerospace, defense, and wind turbine gearbox OEM sectors.

A defining pillar of Michaud's leadership has been the strategic physical expansion of the company to better serve industrial hubs. During his tenure, REM successfully expanded its operations with a dedicated facility in Merrillville, IN, positioning the company at the heart of the Midwestern manufacturing corridor to support aerospace, automotive, and heavy machinery partners. Furthermore, Michaud oversaw the critical addition and expansion of REM's European operations in Germany, securing the company's status as a truly international partner capable of delivering localized technical support and advanced surface engineering solutions to the European Union and beyond.

"I have had the privilege of working at REM under the leadership of two generations of the Michaud Family," says Lane Winkelmann, vice president of technology, "and was part of the transition team mentoring Justin as he took the reins. As the years have passed, I have been very proud of his growth into the CEO position and the growth of REM under his leadership. Justin recognized the potential of additive manufacturing very early and struck a new course for REM, ensuring our position in this new and growing industry for years to come. I did not think it was possible, but Justin's passion for REM matches step-for-step the passion I saw in his father, Mark. REM has a bright future with this generation at the helm. Congratulations on 20 years of service."

Michaud's influence extends far beyond REM's operational footprint. A graduate of the University of Notre Dame, he is an accomplished author of numerous technical papers covering additive manufacturing, isotropic superfinishing, gear failure modes, and surface textures. He also serves an active role in the broader manufacturing community as a member of the Board of Directors for the Motion + Power Manufacturers Alliance (MPMA).

As REM Surface Engineering celebrates this milestone, the company looks toward a future anchored by the same commitment to quality, family values, and international breakthrough technology that Michaud has championed for twenty years.

remchem.com

ATLANTA GEAR WORKS

Names Randy Hand, Director of Field Services

Atlanta Gear Works (AGW) has named Randy Hand as director of field services.

Randy Hand

Hand brings more than 25 years of maintenance, reliability and field service leadership experience, with a career focused on helping paper mills and other industrial manufacturers improve equipment reliability, reduce downtime and maximize production.

In his new role, Hand will lead AGW's growing field service organization, expanding the company's ability to provide onsite gearbox inspections, installation supervision, maintenance support, troubleshooting, outage assistance and emergency field service including field machining for customers throughout North America.

"Randy's experience is an outstanding fit for Atlanta Gear Works and the customers we serve," said CEO Jack Conway. "He's spent his career solving reliability challenges

in demanding industrial environments, leading field service organizations and helping manufacturers improve equipment performance. Just as important, he understands what unplanned downtime costs our customers and how to respond when every hour matters"

Before joining Atlanta Gear Works, Hand served in a series of field service and maintenance leadership positions with Graphic Packaging International, Georgia Pacific and Voith Paper, a leading supplier to the paper industry, where he directed nationwide onsite service operations.

While at Voith, he oversaw more than 100 field service professionals supporting paper and chemical manufacturing customers throughout the United States and was credited with achieving a 49 percent increase in revenue and 60 percent improvement in margins.

Throughout his career, Hand has developed a reputation for improving equipment reliability, strengthening maintenance programs and building long-term customer relationships through responsive, hands-on field support.

His experience includes leading complex maintenance projects, managing major mill outages, implementing predictive maintenance programs and directing multidisciplinary teams of engineers, superintendents and skilled craftsmen serving industrial facilities across the country.

"I'm excited to join Atlanta Gear Works and help expand their already respected field service capabilities," said Hand. "In addition to growing from within, we'll also be relying on the national network of trusted industrial maintenance professionals I've built throughout my career."

"Field service is an increasingly large part of our business. Bringing Randy on board further strengthens our commitment to providing responsive field support and technical expertise wherever our customers need it," said VP-sales Craig Massa. "In addition, he's experienced at building the kind of long-term customer relationships on which we've built our business."

atlantagear.com

SHELL AND DUCATI

Celebrate 100 years of Ducati and 27 years of Partnership

Shell and Ducati have marked a historic milestone during World Ducati Week—Ducati's 100th anniversary—alongside more than 27 years of technical partnership with Shell that has helped shape performance, innovation and success on track and on the road.

For over two decades, the collaboration between Shell and Ducati has grown into one of the most successful technical partnerships in motorsport. Working side by side with Ducati Corse, Shell has supported the team with advanced lubricants technology, contributing to sustained competitive advantage at the highest levels of racing.

The partnership began in the World Superbike Championship in 1999, expanded to MotoGP in 2003 and to MXGP and US Supercross in 2026. Since then, Shell and Ducati have built a relationship grounded in close collaboration, co-development and a shared ambition to push the limits of performance.

At the heart of this collaboration are the Shell Advance technology—the only premium motorcycle engine oil technology recommended and used by Ducati Corse. and Shell V-Power—our most advanced, premium fuel that brings race-track innovation to the road, helping engines run smoother and stronger.

MotoGP continues to serve as the ultimate testbed for Shell Advance technology and V-Power fuel, where lubricants and fuel are developed and proven under the most extreme racing conditions. Insights gained on track are applied directly to road-going products, ensuring that Shell and Ducati customers around the world benefit from the same expertise that powers championship-winning machines.

Every Ducati road motorcycle produced in Italy and Thailand is first-filled with Shell motorcycle engine oil, reflecting the strength of the relationship and the trust placed in Shell's lubricants technology.

As Ducati celebrates its centenary, Shell remains committed to advancing the technical partnership, building on 27 years of collaboration and continuing to drive innovation in motorcycle lubricants. With motorsport as a platform for innovation and collaboration, Shell and Ducati will continue to develop technologies that enhance performance, efficiency and reliability—for riders on the track and on the road.

Jason Wong, EVP global lubricants at Shell said, "Ducati's 100-year milestone is a testament to a legacy of engineering excellence and passion for performance. Over the past 27 years, our partnership has grown into one of the most successful technical collaborations in motorsport. Together, we have pushed the boundaries of innovation through the Shell Advance lubricant technology, translating insights from the track into meaningful benefits for riders around the world. We are proud of what we have achieved together and excited about what lies ahead."

Mauro Grassilli, Ducati Corse sporting director said, "Celebrating 100 years of Ducati is a moment of immense pride for us, and our long-standing partnership with Shell has been an important part of that journey. For more than 27 years, we have worked side by side to develop high-performance solutions, with the Shell Advance technology playing a critical role both on the track and in our production motorcycles. Together, we have achieved remarkable success and continue to push the boundaries of performance and innovation."

shell.com

September 22–23

RPM Symposium 2026

The RPM (Reliability Process & Maintenance) Symposium (Kalamazoo, MI) is a conference event where end users can network and learn about industrial facilities, reliability, maintenance best practices, electric motor driven powertrains, and IIoT. Topics include pumps, gearboxes, vibration analysis, drives, bearings, motors, couplings, condition monitoring, controls, automation and more. A keynote presentation will examine monitoring, maintenance and repairs. Additional sessions will focus on VFDs, managing critical equipment, AI, gearbox validation and pump failure.

powertransmission.com/events/rpm-symposium-2026

September 26–30

Weftec 2026

More than 20,000 water professionals come to Weftec each year to share ideas, spark innovation and move the industry forward. At Weftec 2026 (New Orleans), you'll find exhibits, hands-on learning experiences and a global network of water professionals. The show features 1,000+ exhibitors showcasing the latest water and wastewater technologies, solutions and services. More than 130 technical sessions examine topics such as energy management, maintenance, operations, treatment technologies, global insights, research and development and more.

powertransmission.com/events/weftec-2026

October 18–21

Pack Expo International 2026

Pack Expo International 2026 (Chicago) is where 48,000 attendees from over 40 vertical markets come together with more than 2,600 suppliers to shape the future of packaging and processing. It's the industry's global hub for innovation, collaboration and growth. Attendees represent a wide range of industries, including consumer packaged goods (CPG), life sciences, retail and industrial sectors. Education topics include robotics, cybersecurity, sustainability, digital transformation and more.

powertransmission.com/events/pack-expo-international-2026

November 17–20

Automation Fair 2026

The Automation Fair (Boston) is dedicated to industrial automation and digital transformation. Attendees will experience inspiring keynotes from notable thought leaders, dive deep into training from knowledge experts on the latest technology advancements and explore the newest innovations showcased across an expansive Expo with 120+ exhibitors. Each year, Automation Fair hosts more than 10,000 problem solvers, makers and leaders who are shaping the future of industrial operations. From C-suite executives to operations management to engineers across a range of industries, this four-day event provides opportunities for learning, inspiration and connections for all who attend.

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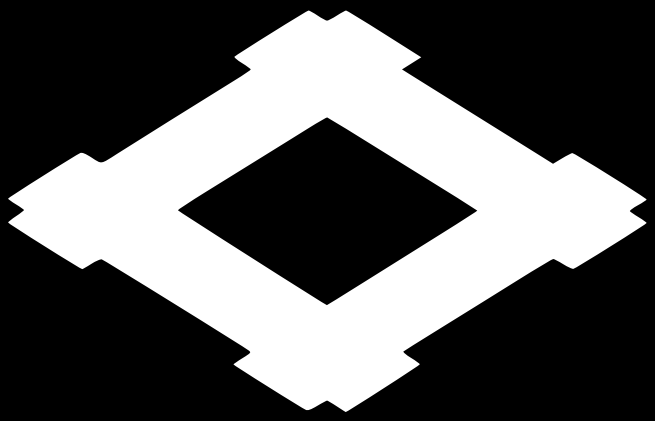

An* igeta*, or well crib—four timbers crossed into a frame. Sumitomo has flown a mark of this kind for four centuries, a house whose gearboxes and film credits turn out to be branches of the same tree.

My wife and I settled in last night to watch *Howards End*—the 1992 Merchant Ivory adaptation of E. M. Forster's novel, all the manners and mannerisms of the manor born, about as far from a factory floor as a film can get. Then a name slid across the opening credits and my wife sat up: "Look—Sumitomo Corporation!" My first thought was, "Now I know what my next 'Power Play' will be!" but I have no idea where this will go from here.

Sumitomo Corporation, one of Japan's great *sōgō shōsha,* or general trading houses—a company that buys, sells, ships, and finances everything, everywhere. The Sumitomo you and I know, the one on the cycloidal gearbox humming on a conveyor line, is Sumitomo Heavy Industries and its motion arm, Sumitomo Drive Technologies. Not the same company but the same family—and to see how a maker of speed reducers and a financier of English costume dramas share a name, you must go back four hundred years.

Sumitomo begins with a former Buddhist priest who went by his religious name, Monjuin. In the early 1600s, under his lay name, Masatomo Sumitomo opened a Kyoto shop selling books and medicine. Near the end of his life, he left behind the *Monjuin Shiigaki*—which Sumitomo renders in English as the "Founder's Precepts"—a letter to one of his retainers, a man named Kanjuro. Its thrust is that you should do everything carefully and honestly, "not only in business, but in every aspect of your life."

Every company in the Sumitomo orbit still points back to it. The fortune came from copper: his brother-in-law had learned a European refining method, *nanban-buki,* for pulling silver from crude copper, and it made Osaka Japan's copper capital. In 1691 the family opened the Besshi copper mine, which ran for 283 years and yielded some 700,000 tons of copper—a load-bearing beam of Japan's industrialization. Mines need machinery, and in 1888, Sumitomo built a machine shop at Niihama, the town around Besshi; that shop became Sumitomo Machinery and, in 1969, Sumitomo Heavy Industries.

In 1938, Sumitomo licensed a peculiar German invention—the cycloidal speed reducer, dreamed up by Lorenz Braren in the 1920s, which rolls a lobed disc around a ring of pins so load is shared across many points at once. Production of the Cyclo drive began in 1939 at Niihama, the very ground of the old copper mine. It has since passed ten million units, and its descendants are probably somewhere in your plant.

So how did that name end up backing a movie? After the war, Sumitomo reassembled into a constellation of independent companies linked by cross-shareholdings. They all fly the same crest: the *igeta,* a diamond mark of four connecting lines symbolizing a traditional well crib of crossed timbers. In the early 1990s Merchant Ivory needed roughly $8 million as its distributor slid toward bankruptcy; much came from Japan, Sumitomo Corporation among the backers—a house whose creed warns against easy gains. The film won three Academy Awards.

Forster gave the novel a two-word epigraph: "Only connect." It seems to echo the *igeta* and precepts. A cycloidal disc does its work by connecting—meshing at dozens of points at once, sharing the load, turning fast motion into slow torque without drama, unlike the movie. Yet gearbox and film are two branches of the same four-hundred-year-old tree. My wife spotted it; I've done my best to make connections.

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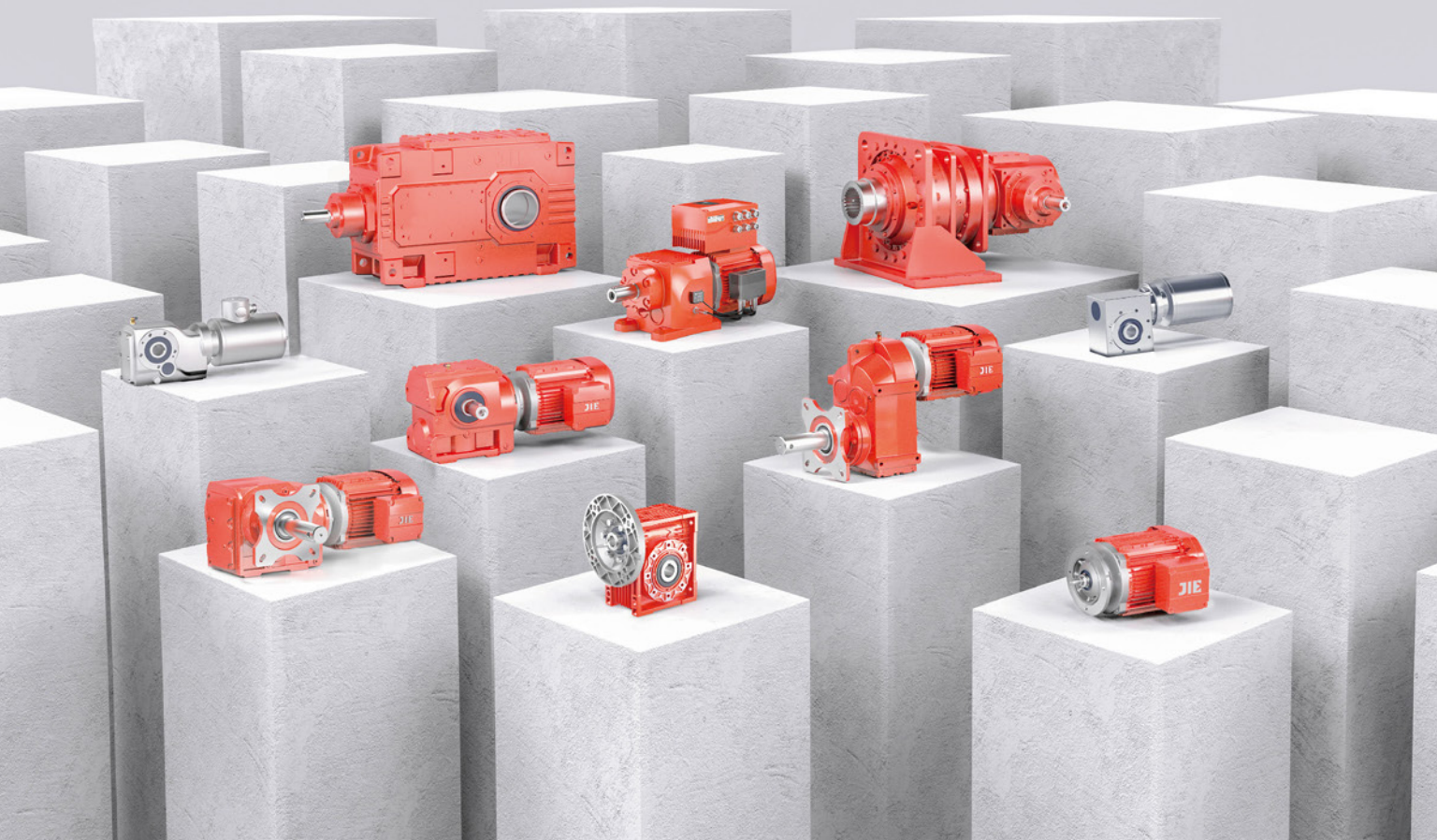

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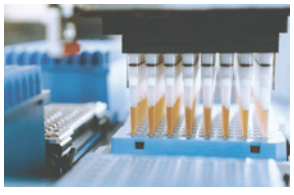

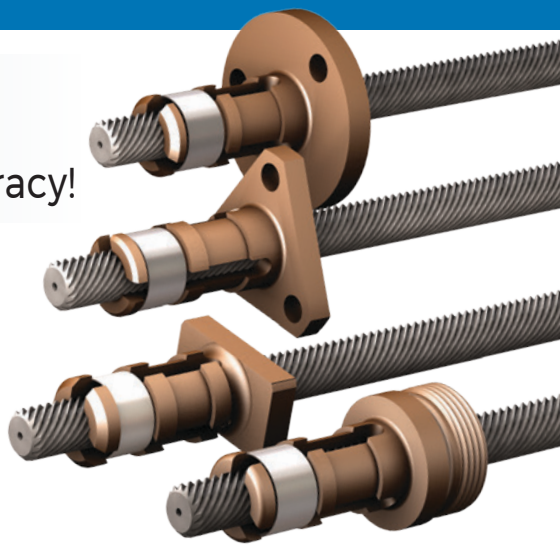

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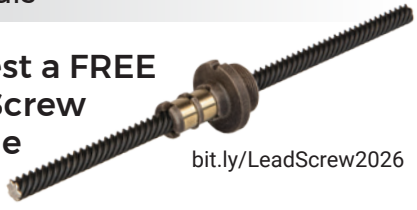

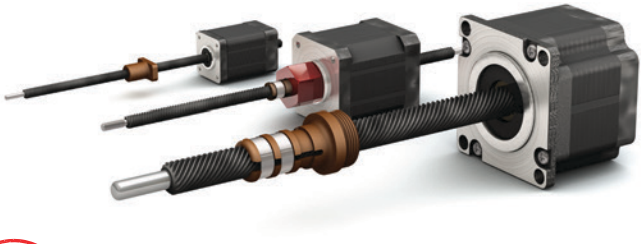

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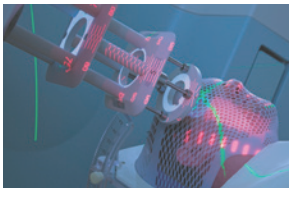

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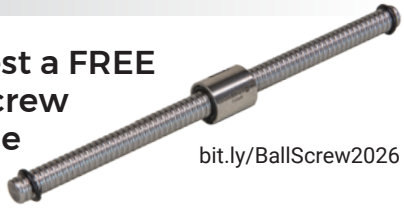

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