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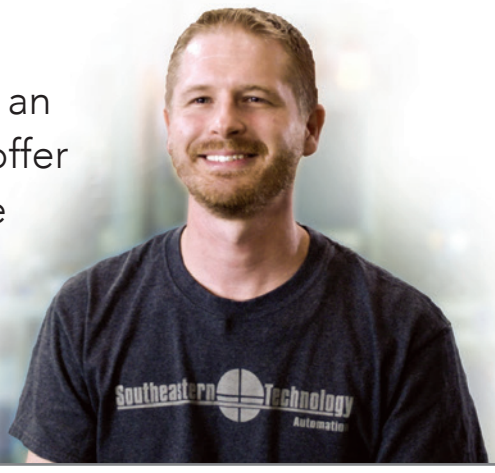

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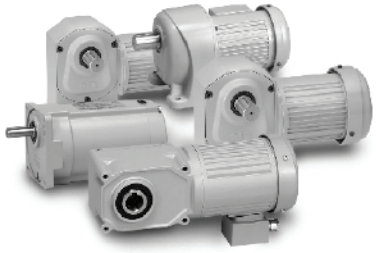

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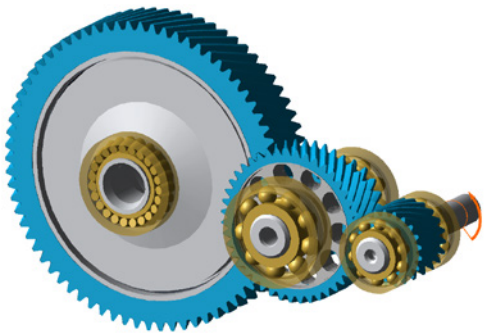

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TECHNICAL ARTICLES

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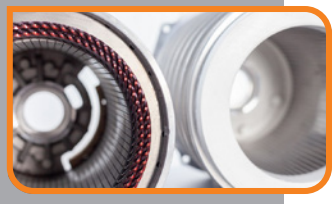
PTE Revolutions

A Look at Heat Dissipation Through E-Drives

Heat is also generated in an e-motor, sometimes quite a bit. In demanding applications, the motor electronics cause the power to be throttled or even shut down completely. But there is another clever way to protect an electric motor from overheating without losing power: using a thermally conductive casting resin as a heat transfer medium. The principle can also be called a static solid cooling system.



powertransmission.com/blogs/1-revolutions/post/9060-a-look-at-heat-dissipation-through-e-drives

An Early Look at Automate 2023

The leading automation showcase in North America, Automate, is back in Detroit May 22-25, 2023, with the latest in cutting-edge robotics, vision, artificial intelligence, motion control and more. Produced by the Association for Advancing Automation (A3), Automate delivers the latest innovations in manufacturing automation technology from more than 600 leading exhibitors.

powertransmission.com/blogs/1-revolutions/post/9077-an-early-look-at-automate-2023

Training Spotlight

Elgeti Engineering Offers Online Bearing Seminar

Elgeti Engineering once again is offering its online bearing seminars for Spring 2023. Special packages are available for online 90-minute sessions. Topics include basics of bearing technology, application engineering, bearing supplier development, and failure analysis.

powertransmission.com/articles/9088-elgeti-engineering-offers-online-bearing-seminar-spring-2023

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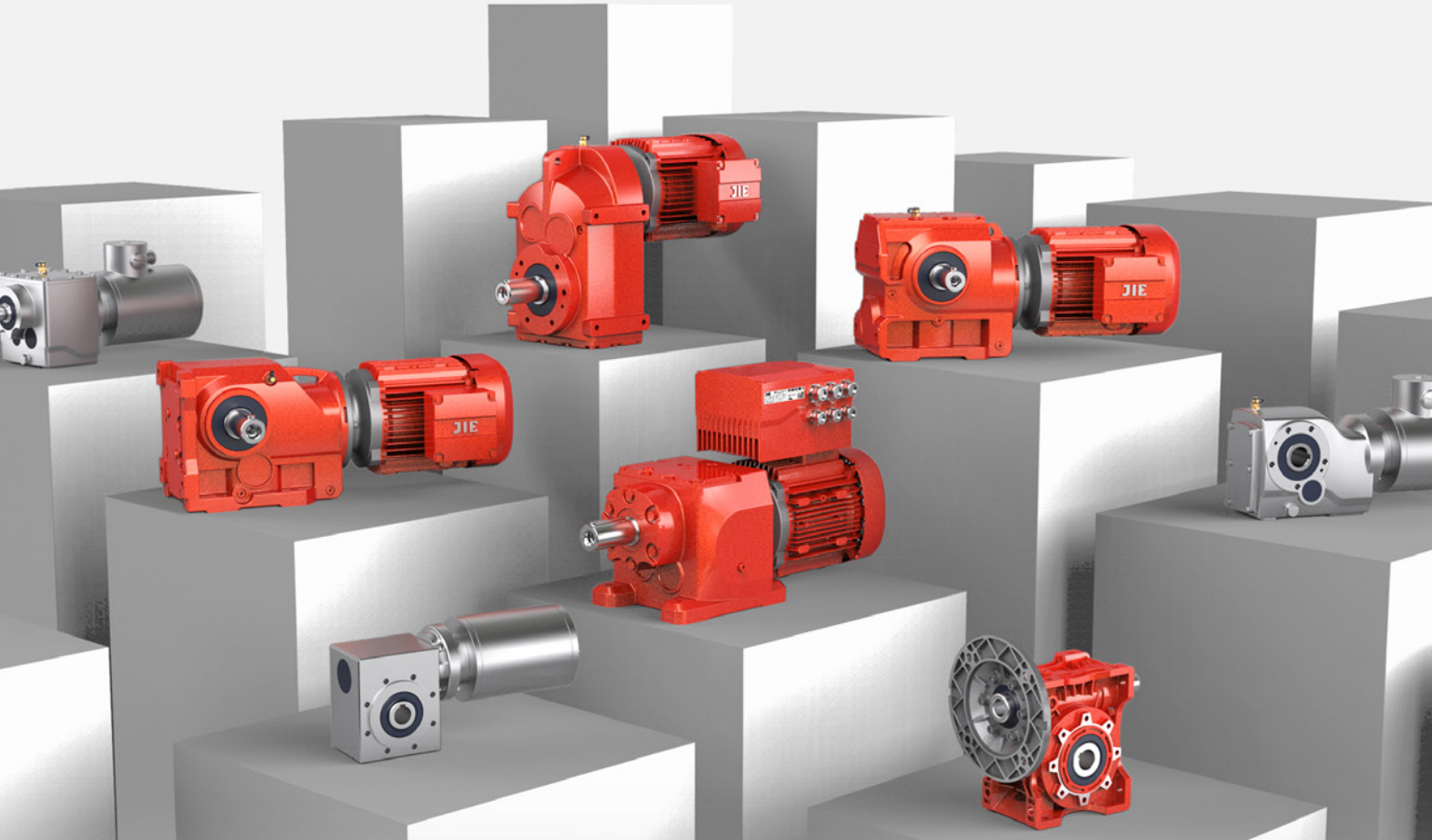

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Randy Stott
Publisher & Editor-in-Chief

Thanks, Team!

As I read through this issue of *Power Transmission Engineering*, I'm reminded of exactly how much hard work goes into producing this publication eight times per year. I thought it would be a great idea for you to get to know a little bit more about the team whose work, too often, goes unrecognized.

Dave Friedman, *Associate Publisher*. In addition to being a talented veteran of trade magazine publishing, Dave is one of the most thoughtful marketing minds I know. As our advertising sales manager, he's the front-line contact with many of the suppliers you read about in every issue. His knowledge of the industry has been indispensable in helping us shape the direction of this magazine since he joined us in 2009. He's genuinely interested in helping our advertisers succeed, and his consultative approach, combined with his many years of experience and knowledge, go a long way toward making sure that the ads you see are the ones most relevant to what you do. If you've ever thought about advertising, email *friedman@agma.org*, and I'm sure he'll help you come up with a plan that makes sense.

Matt Jaster, *Senior Editor*. Since we launched *PTE* in 2007, Matt has been the primary editor responsible for what you read here, as well as online at *powertransmission.com*, in our newsletters, and on social media. If you're a subscriber and you've enjoyed reading our magazine, Matt deserves much of the credit. He's been to countless trade shows and industry events, bringing you the latest information about the technology of mechanical power transmission and motion control. He talks to the people who make gears, gear drives, bearings, couplings, clutches, brakes, linear motion, motion control and much more. He has his finger on the pulse of the latest trends affecting how those components are used in machines, and his in-depth features keep you informed about how those trends might affect you in the years to come. If you have ideas for articles, send them to *jaster@agma.org*.

Aaron Fagan, *Senior Editor*. Although he has only been with us for a little more than a year, and although he spends most of his time working on our sister publication, *Gear Technology*, Aaron is a key member of our editorial team. His attention to detail and ability to understand complex engineering subjects are one of the reasons we're able to produce some of the best technical content related to power transmission technology. Let him know you appreciate his work at *fagan@agma.org*.

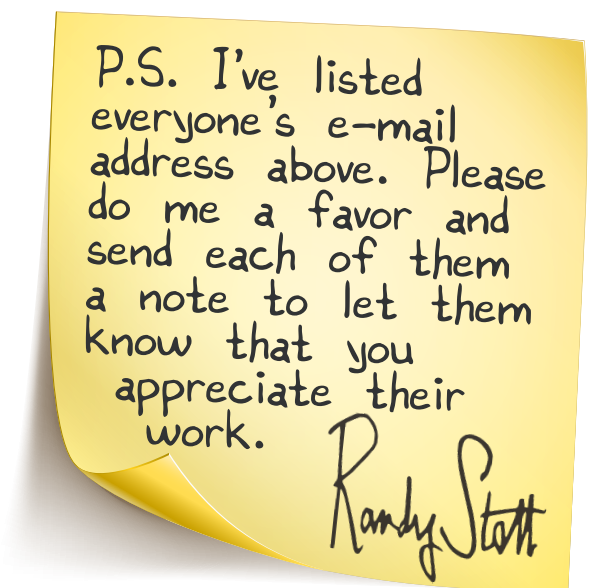
Jess Oglesby, *Graphic Designer*. Jess joined our team in August 2022, and I hope you've noticed the improvements in the overall presentation of our magazine. Our feature articles and technical articles have never looked better. If you happen to be reading this online, then you can also thank Jess, because she's the one who makes sure the great experience you have in print also translates to the websites. Jess is always looking for great cover art for our magazine. If you happen to have photos showing power transmission devices being used in great applications, email *oglesby@agma.org*.

Megan Harrold, *Digital Content Specialist*. Since she joined our team at the beginning of 2021, Megan has been the engine that drives our digital efforts. If you've visited our website or read one of our e-mail newsletters, you can thank her for making sure all the right content is in all the right places and delivered to you in a timely manner. Let her know you appreciate her work at *megan.harrold@agma.org*.

Carol Tratar, *Circulation Manager*. Since 2003, Carol has been the one to make sure you get the magazine on time and delivered to the right place. If you have an address change, or if you haven't renewed your subscription in a while, email *tratar@agma.org*, and she'll help you get it sorted out!

Dorothy Fiandaca, *Materials Coordinator*. Last but certainly not least, Dorothy is the glue that holds everything together. When you call us on the phone, she's the one who answers. More importantly, she's the one who manages thousands of pieces of advertising material each year, and in today's increasingly digital age, that job becomes more and more complex every day. But if you've had the chance to talk with Dorothy, you've probably recognized, as I have, that there couldn't be anyone more dedicated to getting things right and making sure our customers are taken care of. If you need anything from our organization, you can't go wrong by starting with *fiandaca@agma.org*.

In my 29 years of publishing, I've never been a part of a stronger team. I thank them for their hard work, and I look forward to many more years working with all of them to bring you one of the best technical magazines in the world.



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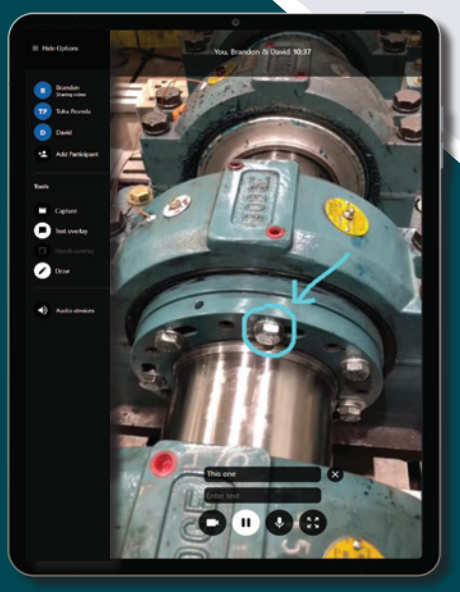

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Force Control

ELIMINATES DOWNTIME FOR INDUSTRIAL LUMBER SAWMILL

For nearly 50 years, AJD Forest Products has been producing top quality industrial lumber for the Lake States region. Located in Grayling, Mich., the company has earned a reputation for supplying high-grade red oak, hard & soft maple, aspen, ash, and basswood. The mill processes 1,700–2,000 logs, or 70,000–90,000 board feet of lumber a day, but constant maintenance and adjustment on their stacker and chain conveyor brakes were forcing unplanned downtime. And that was cutting into the sawmill's profits. Since retrofitting their dry-friction brakes with Magnashear motor brakes featuring Oil Shear Technology, AJD has eliminated brake maintenance and adjustment, and thus unplanned downtime. Now with the mill running smoothly, oil shear brakes are helping AJD Forest Products cut more boards without slashing profits.

A Critical Path Approach

A conveyor chain feeds logs into a sawing station which cuts each side of the log. The log then continues down a conveyor until reaching a backstop, tripping a sensor that engages the motor and releases the brake on a second conveyor which is perpendicular to the first. This second chain conveyor incorporates lugs. Once engaged, logs travel approximately four feet or so to another conveyor which carries the lumber onto further processing. After depositing the log, the lugs trip another sensor which engages the brake and stops the motor, which in turn stops the chain until the next log strikes the backstop, at which point the process repeats itself.

The drive motor was originally fitted with a dry-friction brake. However, continual activation of the brake (1,400 and 2,400 cycles per day) was creating a maintenance nightmare. On average, brake discs were being replaced every three weeks or so. Furthermore, the brakes' heat of engagement was burning up transformers leading to more failures and unplanned downtime.

"We were burning up the transformer because the brake pads would get so hot that the transformer would melt," said Electrical/Automation Technician Damian Fleischmann. "The repetition and the friction were causing so much heat that it was just burning everything up inside."

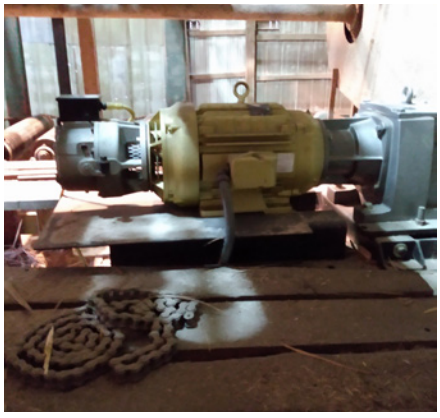
Replacing the brake discs was challenging because the discs first needed to cool-off as to not burn the technicians replacing them.

"We'd wait five or 10 minutes at least for them to cool down, "recalls Fleischmann, "then it was another 10 or 15 minutes to swap out the pads. If the transformer that steps down the 480 V from the motor to the 240 V or 120 V for the brake is damaged, then the process takes a lot longer."

After tallying up the cost of brake pads, the labor to replace them, the inventory cost of stocking complete brakes in case the entire transformer assembly failed, and the unplanned downtime that resulted from brake failures, the team at AJD began searching for a better braking mechanism. In addition to the cost of brake pads, the labor to replace them, and the cost of complete spare brakes stocked in case of total failures, unplanned downtime meant lost production. Clearly there had to be a better way.

When considering their options, the mill production manager recalled a Force Control Oil Shear Brake in another location of the mill that was operating smoothly without downtime for maintenance or adjustment. After conferring with local manufacturer's representative, Dave Dilworth, they purchased a MSB6 size Magnashear which was quite easy to install.

"We have a mechanical starter on ours," said Fleischmann. "I wired up the brake through an auxiliary



contact with the control voltage, so that once the motor is engaged, the brake is disengaged. It is instantaneous on both."

Fleischmann recalls that when he first saw the proposal, he was a little worried about the price. But after six months of continuous uptime, he was convinced. Although he did not perform a formal ROI calculation, he figures "it was a year payback at most, probably sooner." And it is still operating, maintenance-free three years later.

"If we ever have another project that requires repetitive braking, we'll definitely use Force Control" he said.

Stacking Up the Benefits

The installation that Fleischmann's production manager recalled was a stacker. "We have the Force Control brake on a lift at our stacking station" recounted Fleischmann. "Boards are presented to the stacker individually, and the stacker slides six to eight boards onto the lift."

The lift then drops down anywhere from an inch and a half to three inches depending upon the height of the boards. It drops below the sensor to allow space for the next row of boards to slide onto the lift.

Occasionally, the boards are two-by-fours, sometimes two-by-sixes, or two-by-eights, but they can also handle three-by-sixes and three-by-eights. Therefore, the weight of the lift varies, but the reaction time and positioning of the Force Control brake is precise each time. Depending on the line speed, the lift may cycle 75–100 times an hour.

With the old braking system, engaging the brake would generate heat, causing the friction material to

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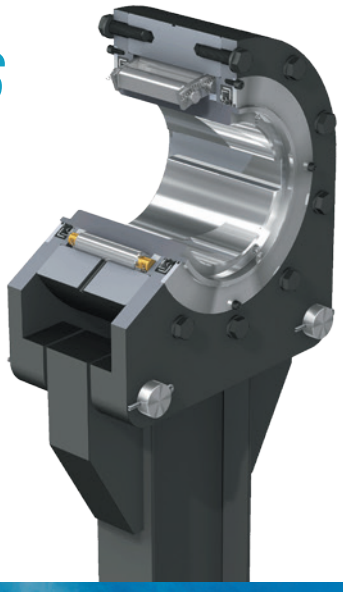

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glaze over. Consequently, this would cause variance on the stopping distance which lead to necessary air gap adjustments. Brake pads would also wear out and require replacement. All of this maintenance and adjustment meant the stacker was out of commission and the mill would remain shut down until the brake could be repaired or replaced.

The MSB6 currently installed on the lift has been in service since June of 2018 and requires virtually no maintenance. "Other than changing the fluid every six months, you don't have to do anything to them," said Fleischmann.

Eliminating maintenance and increasing uptime is important any time, but it is even more important when faced with worker shortages.

"The maintenance on the old brakes was immense and a huge headache," recalls Fleischmann, "but since we've installed the Force Control Brakes, we haven't had to touch them." That's high praise from someone who knows that the best kind of maintenance is no maintenance.

forcecontrol.com
ajdforestproducts.com

SKF

STREAMLINES BEARING ANALYSIS FOR ANSYS USERS

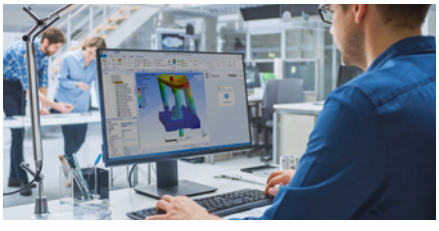
Machine designers increasingly rely on earlier and more predictively accurate simulations to accelerate product development, help eliminate errors and reduce the need for physical prototypes. In many mechanical systems, such as gearboxes or electric drivetrains, bearing performance is a critical driver of overall system performance.

However, simulation of bearings is challenging since their behavior depends on load characteristics and fine geometric details that are not readily available to designers or simulation teams. With the new SKF Bearing App for the *Ansys* mechanical finite element analysis (FEA) software, engineers no longer need to rely on approximations or complex, unreliable models in their simulations.

"With this new integration, we are taking the burden of bearing simulation away from the user's system and doing it ourselves" explains Hedzer Tillema, product manager engineering software at SKF. "Our calculations consider the detailed contacts between the rolling elements and the raceways of the bearing, and full details of the microgeometry."

"The partnership with SKF is a great example of empowering engineers to gain detailed insight into the performance of their designs early on" says Mark Hindsbo, vice president and general manager, at Ansys. "No one knows bearings better than SKF and that knowledge is now available to every *Ansys* Mechanical user."

In the *Ansys* integration, the user first selects their chosen bearing using a user-friendly wizard. The App



then communicates with a SKF cloud server to obtain a predictively accurate representation of the stiffness of a real bearing.

The SKF Bearing App for *Ansys* can simulate any of approximately 10,000 common bearings in the SKF range, and its data is continually updated to ensure that users always have access to the most current, predictively accurate information. The app supports static as well as dynamic analyses where harmonics or vibrations are important considerations.

SKF cloud services are used to deliver predictively accurate, up-to-date information on bearing performance and stiffness to a wide range of engineering design tools. Customers can use these services to calculate key performance parameters such as bearing rating life, friction, grease life and relubrication intervals, static safety, and minimum load. In addition to the new *Ansys* integration, detailed bearing stiffness models are also available for the *KISSsoft* and *FVA Workbench* analysis platforms.

SKF software specialists are continually extending and expanding the capabilities of these software integrations, as well as extending the approach to new platforms, including customers' proprietary in-house product development environments.

skf.com/group/support/engineering-tools/integrated-skf-calculation-services

Kollmorgen

LAUNCHES THE ADVANCED P8000 SERIES WITH THE NEW P80630-SDN STEPPER DRIVE

Kollmorgen recently announced the new P80630-SDN stepper drive. Customers can now benefit from features such as smoothness, precision and torque across the full speed range in a significantly more compact package that enables smaller, lighter, more versatile machines. Kollmorgen will also be introducing additional stepper drives and features in the coming months, building upon the new, flagship P8000 stepper drive platform.

The P80630-SDN stepper drive powers and controls stepper motors operating on 24–75 VDC with up to 5.5 Arms current per phase (7.8 Arms peak). It's an ideal solution for labelers, indexing tables, CNC machines, packaging systems, pumps and other single-or multi-axis systems requiring low-speed, point-to-point motion control for fixed loads.

Building on the success of previous Kollmorgen drives such as the 6410 and P70530, the new P80630-SDN drive delivers improved positional accuracy as demonstrated in laboratory tests

using PMX series stepper motors. This compact, powerful new drive achieves 10 percent greater output current in a 60 percent smaller package that is up to 34 mm shorter in height than the 6410, depending on the model. Moreover, it reduces setup time by delivering smooth, precise performance at all speeds without the need for electronic damping control switches.

The P80630-SDN stepper drive supports conventional single-ended or differential step and direction interfaces (user-provided pulse train required) or CW/CCW command inputs. Dip-switch selectable settings include motor phase current, idle current reduction and step resolution up to 1/128 microstep, all with no programming required. Dedicated enable input and fault output provide control of the drive's power stage and error monitoring. Additional models with new features are scheduled for release in the coming months. Selected drives will also include widely used fieldbus protocols for integration with industry-standard motion controllers. All drives in the series are CE, RoHS and REACH certified.

As with all Kollmorgen products, customers can count on the support they need to optimize motor/drive selection, sizing, setup and performance. Worldwide product availability and Kollmorgen's proven heritage ensure long-term project success.

"The P80630-SDN is the highest-performing, most versatile stepper drive in our lineup," said Ross McMillan, vice president of engineering at Kollmorgen. "And it's just the beginning. The new P8000 series will soon offer an expanded range of drives to power and control Kollmorgen stepper motors in a wide variety of applications where steppers are the best choice. It's always exciting to extend our lead in the motion-control industry and better serve our customers' most challenging requirements."

kollmorgen.com

Thomson RELEASES COMPACT LINEAR MOTION SYSTEM

Thomson Industries, Inc. has introduced a family of compact linear systems that makes it easier for motion designers to implement complex applications in small spaces. Designers needing thrust and bearing support in a single, compact unit now have the flexibility to build such applications with versatile, time-tested components from Thomson.

"As demand for smaller-scale applications grows, so does the challenge of packing high functionality into a smaller footprint. Our new family of compact linear motion systems equips designers to meet those challenges by assembling world-renowned Thomson linear motion components, with the added option of real-time collaboration with one of our engineers," said Matt Palmer, product line specialist—linear motion systems for Thomson.

In building a Thomson compact linear system, a designer can configure a unit or combination of units from a wide variety of components based on their specific application details.

Many features can be customized, including screw diameters and leads, mounting holes and mounting configurations.

To enable engineers to take maximum advantage of such flexibility, Thomson offers an innovative new 3D modeling tool that optimizes their solution by revealing design tradeoffs in real time. The tool, in collaboration with a Thomson engineer, guides the designer in tailoring motor size, stroke length, and other variables to function most effectively within given load and space parameters.

The resulting designs go directly to the Thomson product CAD system, where the information is used to produce the prototype sent for testing. Because of such close user involvement during the design process, the number of design iterations is reduced, which, in turn, decreases the likelihood of mistakes being made.

Applications

Thomson compact linear systems are appropriate for applications requiring

high-accuracy linear axes in confined spaces, such as 3D printers, microscope stage managers, medical pipetting systems and semiconductor manufacturing. They are available with NEMA motor sizes between 14 and 23; stroke lengths of up to 40 in (1,000 mm); and load capacities up to 2,091 lbs. (9,300 N).

thomsonlinear.com

Bosch Rexroth

LOCATOR SOFTWARE OFFERS FLEXIBILITY AND USABILITY FOR MOBILE ROBOTICS

With Bosch Rexroth's *ROKIT Locator* software, mobile robots can independently determine their position. Users no longer need expert knowledge or additional infrastructure to commission a mobile robot. Locator allows mobile robots to determine their position and orientation in any environment, simplifying the automation of intralogistics tasks in industry and trade. Locator is compatible with various industrial controllers and laser sensors on the market and is suitable for mobile units of all sizes and drive types.

Until now, many users have shied away from the effort required to introduce autonomous guided vehicles (AGVs) and autonomous mobile robots (AMRs). Project durations are often several months, and the areas of application in the facility must be equipped with marking strips, reflectors, or mirrors. Afterwards, specialists must manually train the mobile units to effectively navigate their environment.

With *Locator*, this time-consuming process can be replaced with quick and easy commissioning, without requiring additional expert knowledge. Locator enables the robots to evaluate the signals from a laser sensor in the vehicle and convert them into coordinates in space. No permanently installed aids, such as markers or reflectors, are required for orientation and position determination. Users only need one click to start up the system and familiarize the unit with its surroundings in a one-time orientation trip. An intuitive user interface based on 3D technology is provided for this purpose. The software maps an initially unknown environment and automatically creates a map.

Locator stores this map on the vehicle itself, or optionally on an on-site server component, also offered by Bosch Rexroth. If several mobile units are used, they all access this map. Afterwards, immediate localization is possible without initial knowledge.

If a vehicle detects a change in the environment, such as when setting up a new storage location, it sends this information to the server, which automatically updates the map accordingly and sends it to all the mobile units in the fleet. Mobile units purchased subsequently with the Locator take over the server data when they are put into operation and can drive off immediately.

The *Locator* can be used in a wide variety of vehicle types, industries, and applications. The software is independent of the hardware used by a vehicle manufacturer. As an encapsulated function block, it fits into numerous control systems and supports a wide range of laser sensors, including safety lasers. Locator is already being used by various AGV and AMR manufacturers, including Bosch Rexroth's MP1000R and ACTIVE Shuttle.

boschrexroth.com

Siemens Sinamics Drive Series

ADDS FRAME SIZES FOR HIGHER POWER RATINGS

Siemens is extending its Sinamics G120C-series of drives to include three new frame sizes for high power output ranges. The new frame sizes cover the power output range of 22–132 kilo-

watts (kW), making the series available from 0.55 kW–132 kW. Standard features of the series include a compact design with optional filter, long cable lengths, full integration into the Totally Integrated Automation (TIA) Portal and simple control and commissioning. The G120C also includes the "Safe Torque Off" function (STO) which prevents a motor from unintentionally starting.

The three new frame sizes for the Sinamics G120C series include: FSD (22–45 kW), FSE (55 kW) and FSF (75–132 kW), making this compact series of drives ideal for applications requiring higher power ratings. The Sinamics G120C, with its total of seven different frame sizes for operation on three-phase line supplies, features a particularly compact design, as components such as the DC choke and EMC filter are already integrated in the device. This reduces the space required in the control cabinet. The design of the drives also allows all of the frame sizes to be lined up next to one another without any derating.

The parameter settings of the Sinamics G120C can easily be copied to an SD memory card and transferred to other devices. This allows the drives to be reliably cloned without additional technical support and facilitates series commissioning with minimum associated costs. Sinamics G120C drives can also be integrated into the TIA Portal system diagnostics and communicate with Simatic controllers via Profinet and Profibus. This means the control and drive system can be intuitively programmed. The TIA Portal library concept ensures the drives can be easily reused, including their parameters and hardware components. The energy-efficient, sensorless vector control permits high torque levels to be achieved at low speeds. Sinamics G120C drives are ideal for applications such as conveyor belts, mixers, extruders, pumps, fans, compressors, and simple handling machines.

siemens.com

Haydon Kerk Pittman

ONLINE TOOL ENABLES QUICK LINEAR ACTUATOR SELECTION

Haydon Kerk Pittman, a business unit of Ametek's advanced motion solutions division, is pleased to announce its new Haydon Kerk Express online linear actuator calculator.

The Haydon Kerk Express tool joins the Pittman Express tool, released last year, and allows users to now identify and select the right linear actuator for their applications quickly and easily. When a user enters an ideal actuator type, force, and speed, the Express tool returns a list of Haydon Kerk linear actuators that fit these specifications. Once the user selects a specific linear actuator to explore, additional details—including performance curves, specifications and dimensional drawings—are available. Haydon Kerk Express then provides a list of exact and near-match actuators available from Haydon Kerk Pittman's e-commerce site with 24-hour shipment for fast prototyping or proof of concept.

The Express motor calculator is the latest in Haydon Kerk Pittman's series of user-guided tools designed to provide interactive and enhanced product assistance and selection as compared to a traditional website.

haydonkerkpittman.com

Timken

PROVIDES BEARINGS FOR FORD'S ELECTRIC F-150 LIGHTNING

The Timken Company recently announced its packaged wheel bearings are being used on Ford Motor Company's F-150 Lightning, the first mainstream electric light-duty pickup truck to hit the market. Timken bearings on the F-150 Lightning represent incremental content per vehicle, compared to its gasoline-powered counterpart.

"Customers call on us to serve as a trusted technical supplier, utilizing our application engineering expertise to help them improve and differentiate product performance," said Andreas Roellgen, Timken executive vice president, president Engineered Bearings. "We collaborated closely with Ford's team to solve design challenges and support their high standards for safety and performance."

Timken was there to support Ford's timeline and provide an informed perspective on innovating product and process technologies to address the emerging electric vehicle (EV) trend. Timken has been working for many years on advanced designs for EVs, evolving its technology to create solutions that are lighter, smaller and more fuel efficient, yet capable of meeting the unique performance demands of EVs, including higher torque and load requirements. Timken's customized bearing designs are helping manufacturers like Ford switch to EV designs without the need to rethink their entire supply chain.

Timken has a long-standing relationship with Ford, dating back to the production of the Model T in 1908. Timken began providing the wheel bearings for the F-150 Lightning in April 2022. Ford also uses Timken bearings on its Expedition and Lincoln Navigator SUVs, as well as other variations of the F-150.

timken.com

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Lubriplate's complete line of premium quality gear oils has been formulated to provide unsurpassed performance in a wide range of gear reducers.

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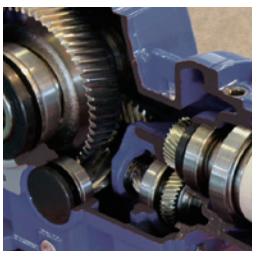

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- For Heavy-duty, high load applications where an EP oil is required.

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

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Making the Move to Digitalization and Electrification

Fluid Power and Motion Control Center Stage at IFPE 2023

Matthew Jaster, Senior Editor

The International Fluid Power Exposition (IFPE), Las Vegas March 14-18, is where fluid power professionals meet to discover highly engineered solutions for improving mobile and industrial equipment's efficiency, performance and sustainability. Attendees will also learn about the latest technology available to the industry and network to discuss and combat the most pressing industrial challenges. From sensor technology and data analytics to robotics, custom software development, and industrial automation, attendees will experience the latest innovations in fluid power. The show is co-located with CONEXPO-CON/AGG, the largest construction trade show in North America.

"The international audience for IFPE is significant," said John Rozum, show director for IFPE. "These are the engineers, the product planners, the executives from OEMs all over the world. The fluid power and motion control technology on display at IFPE is what makes the construction equipment you see at CONEXPO-CON/AGG work, and that doesn't change regardless of where the product is made."

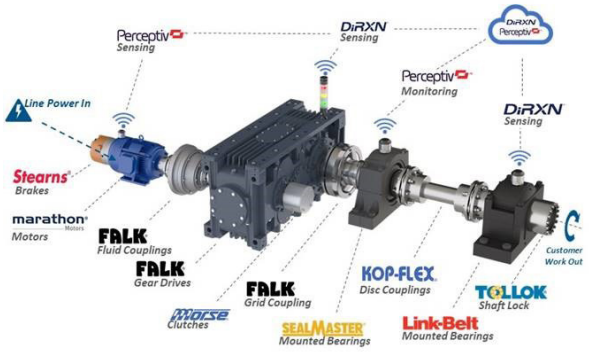
The following is a collection of products and technologies that will be on display during the show:

Regal Rexnord Highlights End-to-End Industrial Powertrain Solutions

Regal Rexnord (Booth #C32490) provides complete, end-to-end and optimized electromechanical powertrains for a wide range of applications and industries. Products that have been engineered to meet specific application requirements for endless potential. Regal Rexnord will help customers to design, assemble and commission their powertrains, and then enhance performance with internet of things (IoT) monitoring via their *Perceptiv* intelligence platform. The *Perceptiv* intelligence platform is an interconnected matrix of smart, digital solutions bundled with the *Tag-It* program to simplify asset management for maintenance and procurement teams. It enables users to reduce maintenance time, streamline the procurement process and achieve inventory objectives by integrating data silos. Plus, users can manage everything in one place using the *Perceptiv* intelligence IoT platform.

This portfolio includes brands from both Regal and Rexnord PMC, including Regal's Browning, Grove Gear, Hub City, Jaure, Kop-Flex, McGill, ModSort, Sealmaster and System Plast brands, as well as PMC's Berg, Cambridge, Centa, Falk, Rexnord and Stearns brands, among others.

In addition to more robust solutions across the industrial powertrain, Regal Rexnord will have opportunities to provide customers IIoT and digital solutions by harnessing the combined capabilities of Regal's *Perceptiv* and Rexnord's *DiRXN* digital platforms. By integrating hardware, software and human-ware, Regal Rexnord will be well positioned to deliver best-in-class solutions optimized for reliability, performance and efficiency.



regalrexnord.com

JW Winco Offers Coupling Technology

Couplings from JW Winco (Booth #S61913) transmit rotary motions and torques from shaft to shaft. They also even out tolerances and mechanical deflection that would otherwise result in damage to drive or measurement configurations.

JW Winco recently added couplings of aluminum and stainless steel that include designs for positive and non-positive connections. Multiple bore diameters, various, stiffness and hardness levels of the coupling body as well as an optional keyway allow very specific customization to the given use case. In general, all couplings compensate for offsets and misalignments,

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accommodate runout error and axial motion, and dampen vibrations and impacts to varying degrees.

At the application level, there is a choice between position and motion control or torque and power transmission.

For position and motion control, the rotary motion must be transmitted with very high precision and accuracy. This requires a coupling type that functions with zero backlash in the direction of rotation and has high torsional stiffness. Typical applications include servo and stepper motors for linear axes, industrial robots and test benches.

For torque and power transmission, on the other hand, the focus is on pure force transmission. This calls for couplings that can withstand high torques and heavy loads while functioning reliably in harsh conditions. Typical applications include conveyor systems, pumps and agitators, packaging machines.

jwwinco.com

Nord Introduces Latest Drive Solutions

Nord Drivesystem's (Booth #S-85214) construction solutions focus on reliability, high-efficiency, and versatility.

Maxxdrive XD industrial gear units are Nord's heavy-duty solution designed specifically for crane and hoist applications. They feature an extended center distance to allow for a U-shaped design with the cable drum and motor on the same side of the gear unit. Compared to Nord's standard, compact Maxxdrive series, the XD center distance has been increased by 35 percent. This includes 3-stage and 4-stage reductions with same overall unit dimensions and center distances for a standardized design, and various input and output shaft and coupling options for easy adaptation to applications.

Maxxdrive industrial gear units deliver output torques up to 2,495,900 lb-in, high load capacity, and a long service life. They feature Nord's trademarked Unicase housing design that ensures precise positioning of bearings and shafts, quiet operation, low maintenance, and increased safety with all joints and components sealed. Due to their robust housing, they can withstand a wide variety of ambient conditions and function both in dusty environments as well as in environments with high humidity, heat, and larger temperature differences. These units are highly configurable and feature a wide range of options including various output shaft options, output flanges, motor attachments, and input options.

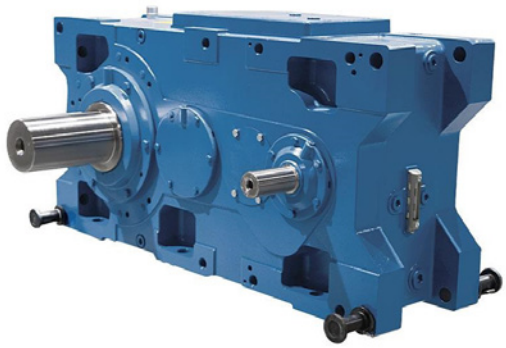
Maxxdrive XT industrial gear units drastically reduce spare parts costs and downtime through their universal, symmetrical housing design for mirror image installations. These units were developed for maximum thermal power and mechanical load capacities and due to their ribbed housing, optimized axial fans, and air guide covers, they can achieve very high thermal ratings without the need for external cooling measures. Modularly attached backstops enable easy maintenance access without costly downtime.

Nord's Unicase helical bevel gear units offer a wide performance range of 0.16 – 268 hp and torque up to 442,537 lb-in. Specialized heavy-duty bearings and spread bearing/flange mount designs enable these units to produce high load capacity, minimum backlash, and long service life. They also achieve a low Total Cost of Ownership (TCO) due to their low maintenance and high efficiency for low operating costs. With numerous shaft designs, mounting options, and bearing concepts, these versatile units are adaptable to countless applications.

Unicase parallel shaft gear units provide reliable operation in a compact, robust design. Their single piece housing protects internal components from debris while delivering quiet operation, a long service life, and requiring very low maintenance. They feature various VL bearing options for maximum radial and axial load capacity, extensive shaft designs, as well as versatile foot, flange, and shaft mounting options. A wide range of configurable, specialized solutions are available with 15 case sizes to choose from, performance up to 268 hp, and torque up to 885,075 lb-in.

Control cabinet variable frequency drives from Nord offer scalable functionality in a compact, cost-effective design. They are compatible with both synchronous and asynchronous motors, provide a high degree of performance, and include functional safety options. Nordac Pro SK 500E VFDs offer performance up to 215 hp and include an integrated Ethernet interface with various optional modules for extended functionality.

Nordac Pro SK 5OOP VFDs are available in five flexible frame sizes and feature multiple easy to use interfaces, high precision regulation and large overload capacities, and full PLC functionality for adaptability to a wide range of applications.



Nord supplies a wide range of synchronous and asynchronous motors that deliver high efficiency, reliability, and significantly reduce energy costs. These motors conform to global energy guidelines and certifications and are designed for combination with Nord's full line of gear units and electronic control products for maximum performance. Explosion protected versions are also available for safe operation in hazardous environments such as dust and gas atmospheres. Add on options such as brakes, encoders, external cooling fans, and environmental protection features are also available to meet the needs of specific application requirements.

nord.com

RBI Bearing Extends Bearing Life with Armor Technology

RBI Bearing (Booth #C30992) offers bearing treatments and protection to reduce bearing failure and extend the bearing life, which means less downtime and reduced repair costs. Armor Nano Technology is a procedure that fuses calcium molecules into the molecular fabric of the metal. Challenging environments involving heat, pressure, or friction activate the calcium causing the particles to elongate and form a protective barrier that reduces the need for lubrication while substantially increasing the lifespan of the bearing – saving you time and money. This isotropic nanotechnology treatment was shown by Oak Ridge National Laboratories to reduce friction up to 99 percent when both pieces of metal are treated.

Armor Coated Protection Bearing Shield offers a UV-resistant thermoplastic polymer bearing shield end users install on site or a spray application of the thermoplastic material applied on site by a trained technician. Armor Coated Protection will immediately prevent contamination ingress and stop corrosion in the bearing housing and bolts as well as reducing the need for purging grease. The inhibiting oil allows the shaft to rotate freely within the coating which prevents the build-up and entry of debris and moisture into the bearing, providing unrivalled protection. The slow-release inhibiting oil prevents corrosion in the bearing casing and fixing bolts as well as lubricating the rotating shaft.

Armor Permanent Lubrication is a solid lubricant with an oil-filled porous structure fills the space between the rolling elements and races in a bearing, providing constant and consistent lubrication. There is no need for additional lubrication during the life of the bearing. Because it is a solid, Armor Bearings Permanent Lubrication can help block debris and reduce foreign contamination of the bearing. Reducing the incursion of debris into the bearing can significantly extend the bearing's life.

rbibearing.com

QCC Displays Pump, Motor and Actuator Technologies

QCC (Booth #S81133) S15 Series pumps and motors are of axial piston design, utilizing slippered pistons. All 15 Series variable pumps feature trunnion style swashplates with direct displacement control.

The 15 Series variable displacement pump is designed for machine applications where up to 15 horsepower is required for the propel function, or for auxiliary work functions where the system pressure requirements and the design life can be met within the pump rating. The maximum pump displacement is 0.913 in3/Rev. (15 cc/Rev.).

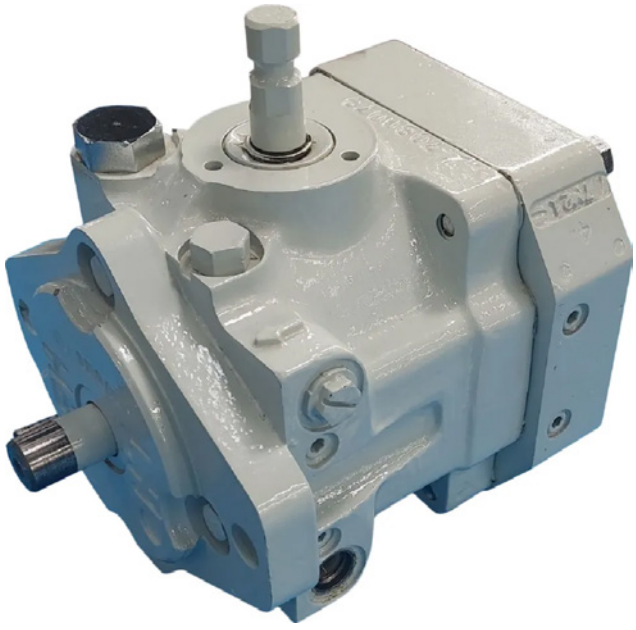
The 15 Series fixed displacement motor is an axial piston unit with a fixed displacement of 0.913 in3/Rev. (15 cc/Rev.). The variable displacement motor has a maximum displacement of 0.913 in3/Rev. (15 cc/Rev.).

QCC took over the manufacture of the Dyna/Barber Colman actuator and sensor product families using the original tooling, assembly and test procedures transferred to us from Woodward/Barber Colman, the Original Equipment Manufacturers (OEM). These products are exact matches to the original equipment part numbers and have been in production for many years with QCC.

Dyna Plus actuators can be operated with Woodward controllers to provide engine governing of speed and power for combustion gas, diesel, steam engines and turbines. The actuators can also be used in remote positioning and load control systems. Dyna Actuators have output work capacities of 1, 4, 6 and 8 ft-Ibs. through output shafts that can be set for clockwise or counterclockwise rotation. Dyna actuators are also available in standard or marine/explosion proof models. QCC also makes electrical speed switches, mechanical speed switches and mini generators to OEM specifications.

QCC took over the manufacture of the Webster CP pumps and motors product families using the original tooling, assembly and test procedures transferred to us from Danfoss the Original Equipment Manufacturer (OEM). These products are exact matches to the original equipment part numbers and have been in production for many years with QCC.

The CP series gear pumps are high pressure, fixed displacement pumps of pressure balanced, spur gear design.



The design has been optimized to provide high efficiency and light weights by using cast aluminum front and rear housings and compacted graphite gear housings. The pressure plates are steel backed bronze for maximum strength and bearing capability.

The CP series consists of two primary product sizes: CP222 series and CP 180 series. Single and tandem versions of both sizes are available, as well as optional auxiliary pads. These pumps are applied in open center, open circuit hydraulic systems to provide output flow and pressure for hydraulic functions.

qccorp.com

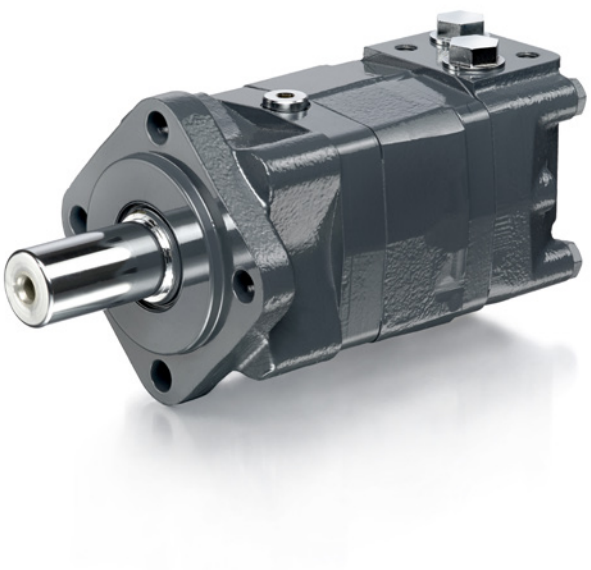
Impro Fluidtek Presents Heavy-, Medium- and Light-Duty Motors

The WS from Impro Fluidtek (Booth #S81957) targets agricultural equipment, skid steer attachments, and other applications that require greater torque under demanding conditions. Additional product features include a three-zone commutator valve, heavy-duty tapered roller bearings, and case drain with integral internal drain. The WS offers numerous housing, displacement and shaft options to meet most common SAE and European requirements.

The WP motor series is an economical alternative to more complex roller gerotor designs and still provides high efficiency across a wide performance range. These motors are intended for light-duty applications requiring high torque in a compact package and are suitable for industrial and mobile applications including car wash brushes, food processing equipment, conveyors, machine tools, agricultural equipment, sweepers, skid steer attachments, and more.

RE Series motors offer the perfect compromise between price and performance by producing work horsepower at a reasonable cost. Although these motors perform well in a wide range of applications, they are especially suited for low flow, high pressure applications. During startup, pressure causes the balance plate to flex toward the rotor, vastly improving volumetric efficiency. As the motor reaches operating pressure, the balance plate relaxes, allowing the rotor to turn freely which translates into higher mechanical efficiencies. Transmitting this power to the output shaft is the most durable drive link in its class. Four bearing options, combined with standard mounting flanges and output shafts, allow the motor to be configured to suit nearly any application.

improfluidtek.com



Optibelt Offers Power Transmission Belts

Optibelt's (Booth #S83659) modular polyurethane synchronous timing belts allows for almost limitless configurations on site. Have a damaged cleat? Modify the product and need new cleats? That is no problem with Optibelt's ATC-System. The ATC-System with tracking guides help keep the belts in perfect alignment on the production line. Even better, the track guide(s) do not affect any of ATC's customization options. Tracking guide options on ATC10K6 include widths of 50 mm and 100 mm. They are available in linear and spliced/welded endless.

The ATC-System is a patented system of modular polyurethane timing belts offering amazing customization and cost savings. Customers can now order standard stocked belts and cleats that can be assembled and customized on site offering faster delivery and greater versatility.

The ATC-System uses the ATC belt as a customizable platform. Each ATC belt's tooth has pre-formed insert and hole punch locations. The insert locations can be "punched" where an ATC cleat/attachment needs to be added. The cleat is simply screwed into the topside of the belt into the insert embedded in the tooth.

The ATC cleating system is strong enough to handle assembly fixture attachments or be used to convey products from one location to the next. There are hundreds of cleating options available to handle a variety of manufacturing needs. Facilities can have even stock ATC belts and cleats to replace worn belting or replace individual cleats on demand.

optibelt.com

Stiebel Drive Technology Features Pump Drives and Gearboxes

Stiebel Drive Technology (Booth #S80153) provides standard and customized solutions for pump drives and transfer case gearboxes. Applications range across any industry using mobile class machinery and includes roadbuilding, construction, agricultural, transportation, marine, railway, mining, forestry and more. The Type 4462 Six Output Pump Drive is intended for heavy duty applications. It can be paired with A7V 1000 and A4VG 250 pumps. It features two output pads on the gearbox input side and four on the output side, this unit also boasts an oil recirculation pump to assist when this particular machine is operating on slopped hills and terrain, avoiding starving the upper gears of lubrication. The Type 4384 Four Pad Pump Drive can accommodate pump sizes SAE-B, C & D and is available with either SAE-1, 2 or 3 Bellhousing or Input Flange 150, 180 or SAE 1800.With a rated input power of 720 hp (530 kW) and

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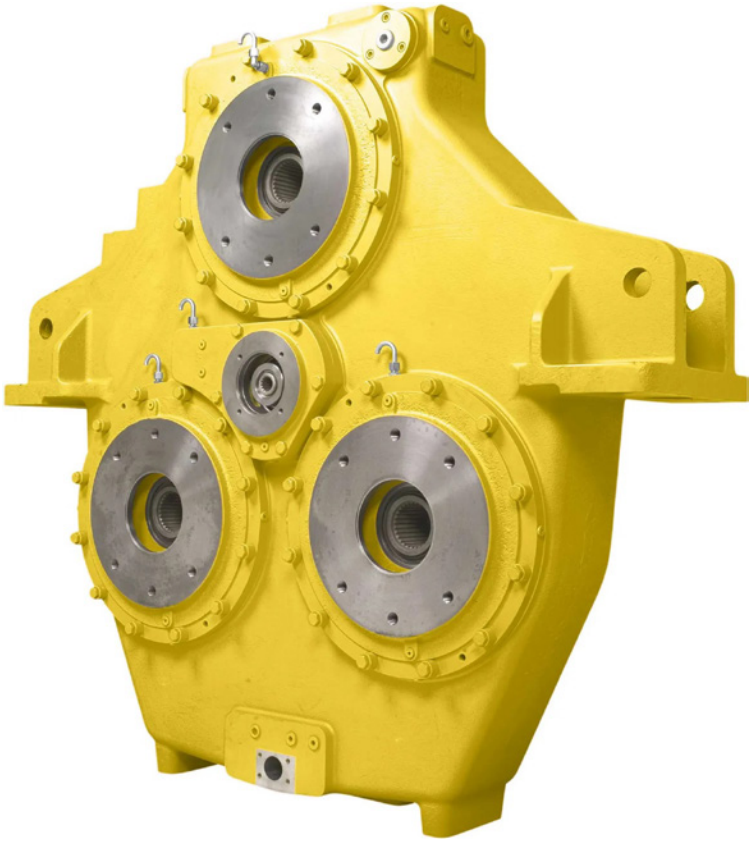

twelve (12x) ratio options, this versatile gearbox is suitable for a variety of machine platforms, including forestry, utility, construction or agricultural to name a few.

stiebel.de/en

Danfoss Highlights Machine Performance

Danfoss (Booth #S80515) will demonstrate how the company is "Powering the future of machine performance," during IFPE 2023.

"Autonomy, electrification, connectivity, and digitalization aren't just buzzwords. They're enabling original equipment manufacturers to develop machines with better productivity, safety, efficiency, precision, and operator experience," said Mike Hill, senior vice president, OEM sales, Danfoss Power Solutions. "At Danfoss, we're helping OEMs harness these trends and working with them to design, iterate, and validate their machines faster. It's how we're powering the future of machine performance."

With dedicated booth areas for autonomy, connectivity, and digital tools, plus the company's Editron electric powertrain systems, Danfoss will highlight how it's paving the way to autonomous machines and zero-emission construction sites as well as delivering next-generation performance through smart, connected solutions. Stations showcasing system solutions for excavators, telehandlers, skid steer loaders, and wheel loaders will demonstrate Danfoss' application expertise and how it helps OEMs increase speed to market. A variety of the company's key products will be on display in these areas, including two of its newest releases: Thorx cam lobe motors and the Dextreme system for excavators.

Danfoss Thorx cam lobe motors reduce shock at speed changeover by 70 percent, improving machine handling and operator comfort. With an integral parking brake, the motor is 33 percent shorter in length than other cam lobe motors, reducing space requirements. In addition, the motor's optimized brake technology lasts 20 to 25 times longer than competitive products, extending the motor's service life.

Based on Digital Displacement technology, the Dextreme system provides a pathway to 50 percent energy savings by tackling losses in the whole excavator hydraulic system. With the most efficient and controllable hydraulic pump at its heart, the Dextreme system

provides unique digital flow control, resulting in vastly improved system efficiency and faster operator response times. Through the fast response and digital control of the hydraulic pump, engine loading can be controlled, providing significantly reduced fuel consumption without compromising on productivity.

Visitors can also see Danfoss' fluid conveyance and industrial hydraulics portfolios. The company's comprehensive offering of hose, tubing, fittings, and connectors will be highlighted. In the industrial zone, the Vickers by Danfoss line of pumps, motors, valves, cylinders, and brakes will be on display.

danfoss.com
PTE

Peering into the Crystal Ball on Condition Monitoring Technology

The future of smart components for motion control systems looks bright

Aaron Fagan, Senior Editor

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Smart components are designed to improve the overall performance of motion control systems by providing advanced features like condition monitoring, real-time data tracking, self-diagnosis, and fault detection, to name a few. These features are designed to significantly reduce downtime and enhance the safety and reliability of the system and play an important role in improving the performance and functionality of motion control systems, making them an increasingly popular choice for industrial automation applications.

There is an increasing trend toward integrating evermore compact smart components into larger, more complex motion control systems, and advances in AI, ML, and IIoT are helping with the speed and quality of their adoption. The future looks bright for this sector—as demonstrated by the current offerings showcased here from Liebherr, Nord, and John Crane—with many exciting advancements and improvements expected in the coming years.

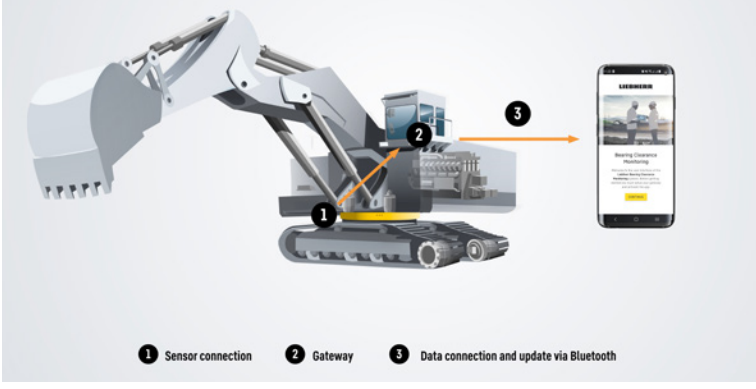
Digital Clearance Monitoring for Slewing Bearings from Liebherr

With the condition monitoring system for slewing bearings, Liebherr has created a digital monitoring system. The integrated wear measurement system, bearing clearance monitoring (BCM), ensures optimum monitoring of the slewing bearings in various applications, such as mining and material handling equipment or maritime applications. The BCM system can be used to measure bearing wear in axial and radial directions as well as tilting clearance. Such diagnostics ensure flexibility in measurement, as well as reduced downtime, lower costs in maintenance, and above all, higher personal protection.

Safety Measures in the Danger Zone

The focus of digital clearance maintenance lies in personnel safety. "A distinct disadvantage of all common wear measurement methods is the necessity for service technicians to mount dial gauges or other measuring devices directly on the slewing bearing in the danger zone under the excavator or other machines," explains Stefan Milotzke, head of technical sales of the business unit slewing bearings. "The Liebherr BCM system makes this unnecessary, as the measuring devices are already permanently installed on the bearing." Another advantage is flexibility in terms of time. Currently, machine operators commission external service providers to measure the bearing clearance. This makes them dependent on the experience and schedule of third-party companies. "With digital maintenance for slewing bearings from Liebherr, measurements can be carried out at any time outside the danger zone, independently of external service providers," explains Stefan Milotzke.

The danger zone of the excavator is located directly at the point, where the service personnel attaches the measuring device during manual measurement.



This is how Liebherr's bearing clearance monitoring system works.

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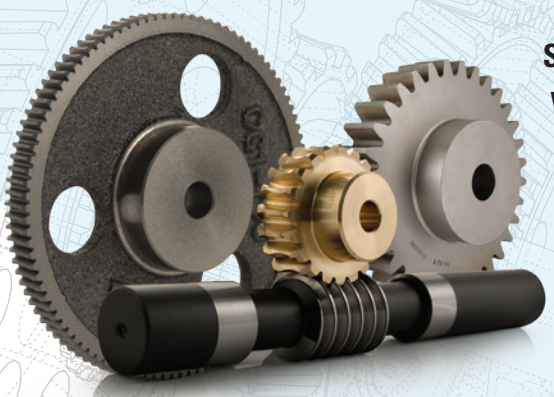

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Measurement Within Minutes

How does BCM work? The right technology and the right connection make it happen. The sensor connection box receives the data from the sensors attached to the slewing bearing and supplies the entire BCM system with power. The gateway stores the sensor data and updates for the BCM. This allows using the system in even autonomously in regions without a data connection. This is the case in mines, for example, as these often do not have the necessary mobile reception. A direct connection via Bluetooth makes the measurement process possible from a safe distance and without a network connection. Smart, integrated and remote, the BCM system is a small helper with great effects.

liebherr.com/en/int/products/components/large-diameter-bearing/smart-bearing-condition-monitoring/smart-bearing-condition-monitoring.html

Condition Monitoring for Predictive Maintenance from Nord Drivesystems

With condition monitoring for predictive maintenance, drive and status data are recorded at regular intervals or continuously to optimize the operational safety and efficiency of systems. The results derived from data analysis enable machines to be proactively maintained and avoid unplanned downtimes. This status-based maintenance approach prolongs the service life of components and machines, increases system availability, and reduces service and material costs. Condition monitoring can even determine the optimal time to change oil, ensuring systems are always operating at their highest capacity.

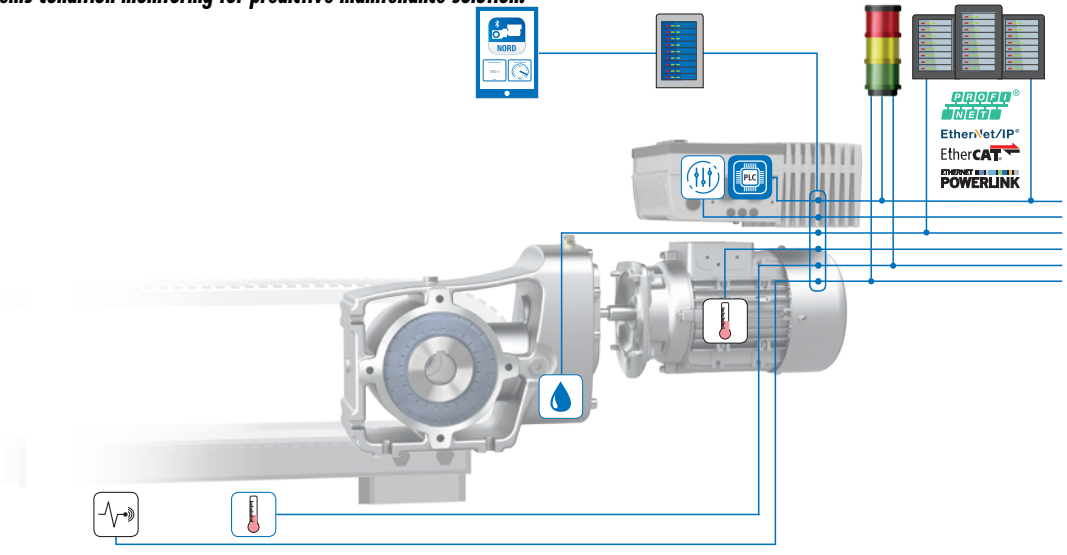
Nordac Pro variable frequency drives from Nord Drivesystems enable dynamic control of gear units, provide precise control, and can be easily configured to meet application needs. They are characterized by their compact, space-saving design, advanced control characteristics, and uniform parameterization. Their versatile functionality is available in five frame sizes with powers ranging from 0.33–30 HP with optional modules to extend features.

Nordac Pro SK 500P family of variable frequency drives (VFDs).

Ease of operation is achieved via several interfaces including an integrated multi-protocol ethernet interface for connectivity to ethernet-based control systems, a USB interface that enables parameterization even when the main power is disconnected, a Bluetooth interface, and an SD memory card slot for storage and transfer of parameters, firmware, and operating data. Integrated programable logic controller (PLC) functionality and Posicon positioning control provide further intelligent control optimized for specific system needs. Functional safety is also implemented with safe torque off (STO) and safe stop 1 (SS1) options for safe shutdown to prevent hazards to people and damage to system components.

Nordac Pro variable frequency drives (VFDs) are a part of Nord's modular product system and are compatible with both synchronous and asynchronous motors. Sensorless current vector control enables high starting torques and precise control of motor speeds. The drives also feature motor brake management, lifting gear functionality, a brake chopper, and extensive monitoring functions. Thanks to their

Nord Drivesystems condition monitoring for predictive maintenance solution.



System vibration sensor
- NORD qualified sensors
- Customer-specific sensors can be connected (analogue / digital)

Temperature sensor
- Motor temperature sensor on the basis of PT1000
- Ambient or system temperature

Oil change
- Determination of the optimum time for oil change on the basis of the virtual oil temperature
- Algorithm is executed in the internal PLC

Drive parameters
- Read-out of the drive parameters of the drive system
- Basis for virtual sensors

Integrated PLC
- Pre-processing of drive-specific parameters and drive-related sensors
- Evaluation of drive condition

Beacon signal
- Local display of drive condition
- Status display

Lokal dashboard
- Display of drive data and system data

Local data management
- Processing of drive data for drive analysis and system analysis
- Condition Monitoring

Higher level PLC
- Processing of condition monitoring information by the customer
- Combination of condition monitoring information with process data

high level of performance, safety, and versatility, Nordac Pro VFDs are used in a wide range of industries such as airport baggage handling, intralogistics, bulk material handling, packaging, and more.

Nord's answer to supply chain solutions is its modular product design that aims to deliver versatility with millions of unique configurations of gearboxes, electric motors, and variable frequency drives—eliminating the need for costly custom components.

Nordac On/On+ VFDs

Nordac On/On+ VFDs offer a compact, flexible design developed to meet the specific requirements of horizontal conveyor technology. Nordac On VFDs are designed for use with IE3 asynchronous motors while Nordac On+ VFDs have been optimized for performance with IE5+ synchronous motors. These VFDs feature an integrated Ethernet interface, full Plug-&-Play capabilities, and functional safety options such as STO and SS1. With precise positioning and full PLC functionality for dynamic control of conveyor systems, Nordac On/On+ VFDs provide a reliable, cost-effective solution for IIoT environments.

IE5+ Synchronous Motors

IE5+ synchronous motors achieve ultimate efficiency in a compact, versatile design that can be installed quickly and easily. They are available in two versions—a non-ventilated variant (N-design) for hygienic wash-down areas and a ventilated variant (F-design) with high overload capacity suited for intralogistics. IE5+ motors provide a standardized, high-efficiency solution thanks to their constant torque over a wide speed range. This enables them to eliminate the need for system variants, minimize operating costs, and increase energy savings.

DuoDrive Integrated Gear Unit and Motor

The DuoDrive with an integrated IE5+ motor and single-stage helical gear unit brings a new level of energy efficiency and easy system maintenance. The compact, modular design features full Plug-&-Play capabilities for fast commissioning, quick installation, and minimal space requirements. Constant motor torque over a wide speed range enables system variants to be reduced—minimizing administrative expenses and optimizing service processes. The DuoDrive is especially suitable for supply chain applications due to its high-power density, extremely high system efficiency of up to 92%, and quiet operation.

LogiDrive Complete Drive Solution

The LogiDrive solution is a service-friendly, modular system designed for standardization and reduction of system variants. The package combines a gear unit with high overload capacity, a high-efficiency electric motor, and a compact variable frequency drive for a complete solution that is flexible, low-maintenance, and Industry 4.0 ready. Efficient operation at partial load and low speeds makes LogiDrive especially suited for a variety of conveyors in high-volume warehousing, parcel distribution systems, and packaging systems.

Two-Stage Helical Bevel Gear Units

Two-stage helical bevel gear units deliver efficient operation in a compact, robust design ideal for conveyor systems. They feature a large speed range, quiet operation, and high axial and radial load capacities. Flexible installation options are available including various input and output options, solid and hollow shafts, and foot, flange, or shaft mounting—making the drives highly adaptable to a wide range of applications and environments.

Nordbloc.1 Helical Inline Gear Units

Nordbloc.1 helical inline gear units are characterized by quiet, reliable performance in a smooth, easy-to-clean design. Their Unicase housing is made from high-strength, low-weight aluminum alloy and ensures a long service life with increased stability and safe operation. They offer 13 case sizes to choose from as well as a performance of 0.16–60 hp, keyless shaft designs with Shrink Disc and Gripmaxx, and foot or flange mounting. High output torques paired with efficient operation reduce system costs for a lower total cost of ownership (TCO) and a fast return on investment (ROI).

nord.com

Seeing Into the Darkness of Seal Health with John Crane

John Crane, a global leader in rotating equipment solutions, supplying engineered technologies and services to process industries, offers John Crane Sense Turbo, a dry gas seal digital diagnostics solution to monitor conditions at the heart of the compressor.

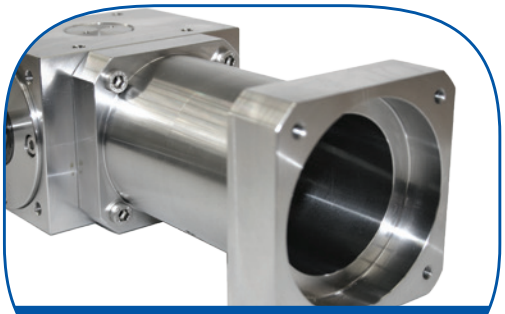
John Crane Sense Turbo uses a unique set of sensors embedded directly into a compressor's dry gas seal to deliver continuous, real-time insight to identify potential issues and ensure corrective actions are taken to extend the useful life of the seal. Designed to improve reliability, reduce the risk of failures and unplanned downtime, and increase the mean time between repairs (MTBR) while increasing efficiency and profits, John Crane Sense Turbo monitors conditions that impact seal health.

Data from different sensors are combined, processed at the edge, and sent to cloud servers for additional real-time processing and archiving, using industrial-grade cybersecurity. Access to secured and actionable information is available on any device, using enterprise-grade cybersecurity in the cloud with multifactor-protected data portals.

"Leveraging machine learning, John Crane Sense Turbo allows customers to assess the health of dry gas seals installed in turbomachinery and understand how to optimize the reliability and performance of their rotating equipment," said John Crane Product Line Director, Digital, Brian Boykin. "By understanding the remaining useful life of a mechanical seal, our customers can add months, if not years, to the time before repair of their equipment, while significantly reducing maintenance costs at the same time."

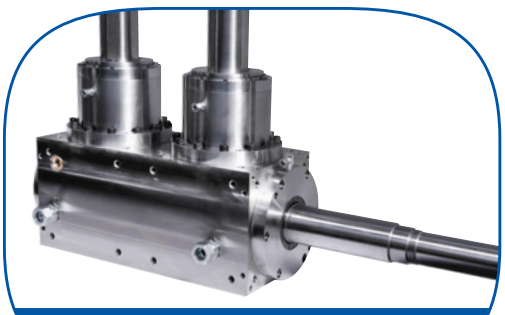
When off the shelf just won't do.

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

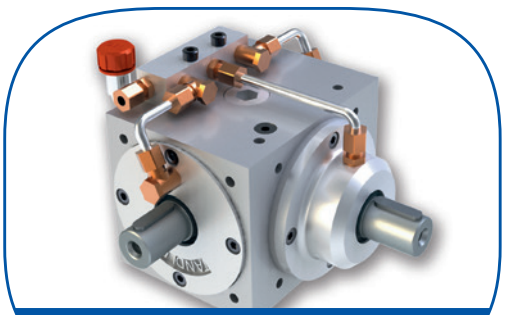


Custom Flanges

Custom Paint



Complete Redesigns



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Motion Control and Power Transmission Drive Components

John Crane Sense Turbo is part of the John Crane Sense platform and suite of solutions including John Crane Sense Pumps and John Crane Sense Monitor designed to transform industrial equipment to build a better understanding of asset health through the digitization of critical components. Sense is an open platform for a suite of apps that provide actionable information. The pumps are a digital health monitoring system that leverages years of experience in mechanical seal expertise, combined with machine learning technology to provide insight into the health and performance of the pump asset. And the monitor is a wireless monitoring solution that enables visibility into asset health and performance across the entirety of the plant or site, including in the most remote locations.

Change is everywhere in our industry and we're all under pressure to spot efficiencies and do more with less while staying competitive. As the impacts of climate change become clear and the demand for cleaner energy grows, we all need to find ways to work smarter to hit emission reduction targets, future-proof businesses, and protect the world for future generations.

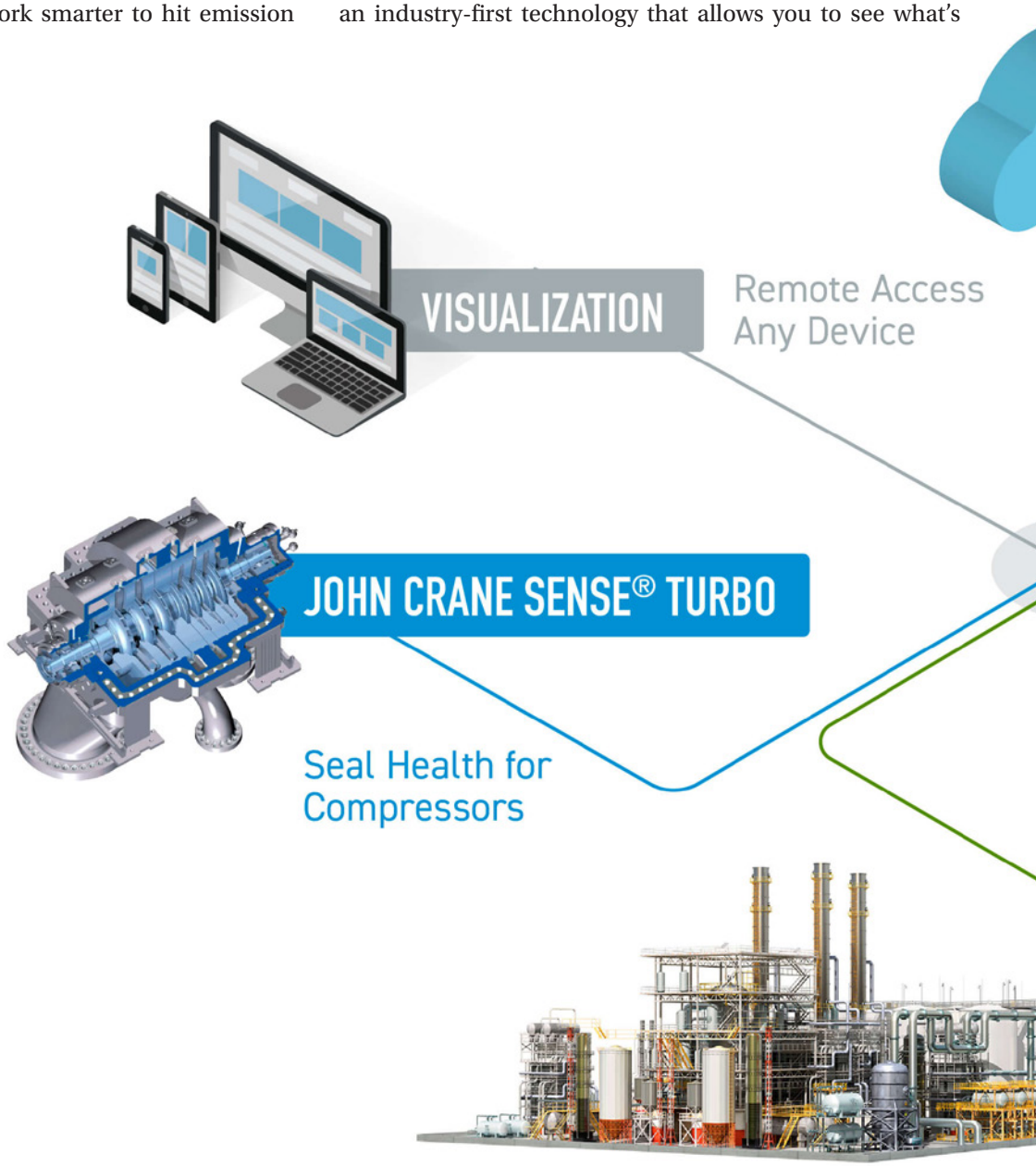
Digitization will play an essential role in helping the industry to meet these challenges. Today, only one-third of oil and gas businesses are approaching digital maturity. As the industry evolves toward a cleaner, greener, and more cost-efficient model, that number must change quickly.

The Power of Digitization

There are clear opportunities for the oil and gas industry to adopt the kind of digitized, data-driven approaches that have transformed other industries—even if the technology that drives them is more complex.

Put simply, when you don't have the right data, you rely on estimates and approximations to make critical business decisions. When you do have the right data, you can move forward with facts—and confidence.

That's why we developed the John Crane Sense platform—an industry-first technology that allows you to see what's



The John Crane Sense open platform is designed to allow third parties, component OEMs, and end users to digitize

going on in the heart of your critical operations and make more informed decisions about maintenance and repair to reduce downtime and extend the useful life of your assets.

Digitization in Practice

John Crane Sense Turbo is an excellent example of the way that digitization can drive new benefits. The Turbo solution consists of sensors embedded into a dry gas seal that monitor process conditions and seal health.

By using John Crane Sense user interface, you can monitor the seal from anywhere and receive alerts about process upsets or other operational irregularities. This allows you to respond immediately before manageable issues become more significant failures that require downtime.

It also ensures you're getting the most out of your equipment. Traditional forms of seal monitoring provide some information, but they don't give a complete picture or sufficient indication of a seal's health. Understanding health is critical to shortening the duration of an unplanned shutdown. Knowing a seal is healthy can enable you to defer replacement, saving on both equipment cost and downtime.

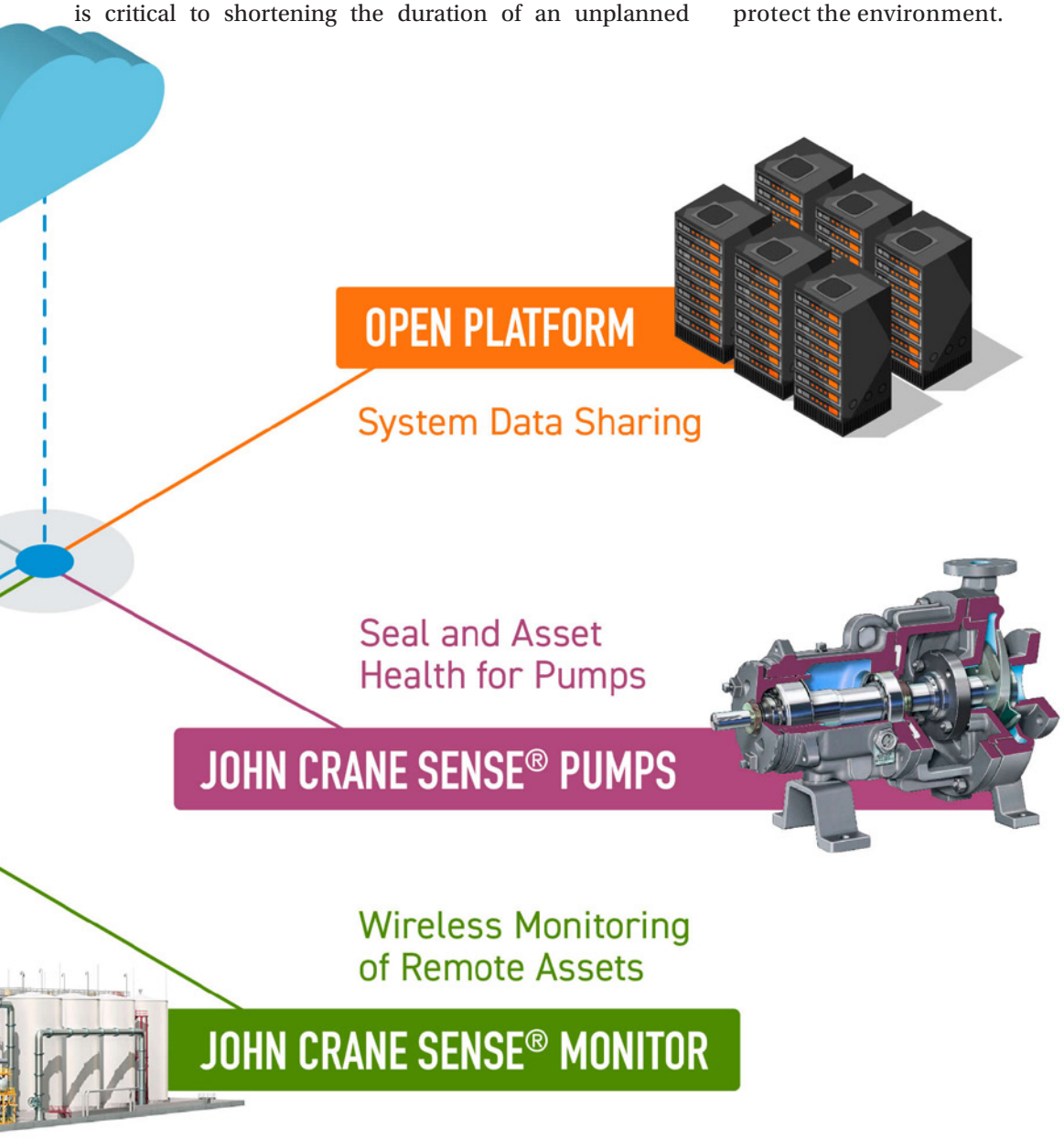
Seeing into the Future

Technology like John Crane Sense platform is only the beginning. As the move toward digital accelerates, new opportunities will be available to seamlessly connect data from other parts of your plant and ensure every decision you make is working toward the same goal.

Smart seals are a key component in meeting emission reduction targets—monitoring leaks that, unless identified and fixed proactively, will cost your operation and contaminate soil, water, and air.

The future is only going one way—greater digitization of equipment, processes, and plants. The John Crane Sense platform can help you on your digital transformation journey, giving you the intelligence you need to hit tomorrow's targets, enhance your brand reputation and protect the environment.

johncrane.com
PTE

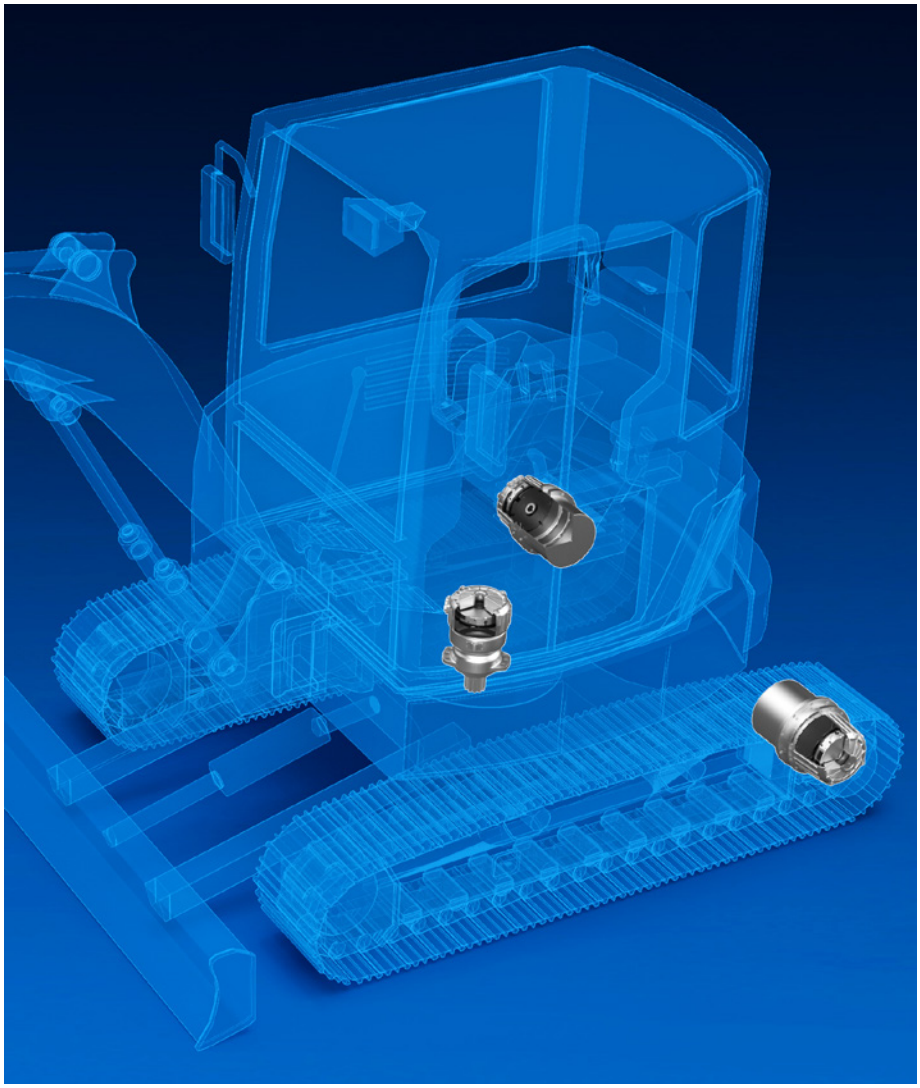


their physical devices with application development support from John Crane.

The High Demands of Off-Highway Drive Systems

Customization takes center stage in the push for more efficient motor, brake and drive concepts.

Matthew Jaster, Senior Editor



Warner Electric application engineers routinely work with Tier 1 drivetrain OEMs as well as major construction equipment manufacturer engineering teams to develop compact, energy efficient braking solutions.

Motor and brake manufacturers are facing increased pressure to provide off-highway components with energy efficient and sustainable benefits. This transition starts during the design phase as engineers provide optimization in areas like noise, vibration, and harshness (NVH) as well as comfort, safety, and health considerations. The following off-highway, construction and mining solutions hint at the all-electric transition taking place across each industry.

Warner Electric Presents Customized Braking Solutions

The off-highway industry is currently moving through a significant transition. The journey started about 10–12 years ago as the forklift truck industry began converting from internal combustion engines into electric drives. Today, construction equipment, more precisely, compact construction equipment, has also begun the transformative conversion to electric drives.

As with the automotive industry, national and municipal emission regulations are rapidly becoming more restrictive for off-highway vehicles and equipment. In some areas, the use of gas-powered equipment has already been completely banned. Some analysts believe that by 2030, 50 percent of the construction equipment market will be electric powered.

As environmental awareness grows, construction equipment manufacturers have begun to respond with electric powered equipment that meets various mandated emission regulations. However, they are also being driven by voluntary environmental policies adopted by construction contractors and large equipment rental companies. This new generation of much quieter equipment is not only environmentally friendly, but also provides increased operator comfort, health and safety benefits.

Warner Electric offers innovative braking solutions designed to reduce power consumption on a wide variety of battery-powered construction equipment, including slewing and track drives on excavators, wheel and track motors on compact track

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Customization of a Warner braking unit includes IP rating, manual release cables, connectors, sensors, and friction material.

loaders, skid steers, wheeled excavators, compact dumpers and mobile elevating work platforms (MEWPs).

Highly experienced Warner Electric application engineers routinely work with Tier 1 drivetrain OEMs as well as major construction equipment manufacturer engineering teams to develop compact, energy efficient braking solutions to meet the needs of each vehicle requirement, whether it's for a completely new design or the electric conversion of existing equipment.

The design process typically starts with one of Warner's existing braking solutions, including the PK and CBTB ranges. Once selected, customization of the unit begins, including IP rating, manual release cables, connectors, sensors, and friction material. The result is a "plug and play" product that the OEM can easily integrate into a drivetrain.

Warner Electric's PK (Very Thin) brakes are used for parking and offer emergency stop capabilities. The vehicle's AC motor is used in combination with the PK brake for regenerative braking of the vehicle.

The benefits of this cost competitive range include one-piece design for easy assembly, lower power consumption, longer battery life, and overall lower maintenance costs. These brakes are enclosed to withstand harsh outdoor environments. IP67-Rated models are available to meet challenging washdown application requirements.

The recently launched PK–Low Noise Design brake features a unique patent-pending dampening system that significantly reduces operating (engagement) noise to below 70 db. The new brake was developed for applications where high noise levels can be annoying such as under-cab slewing drives on mini excavators.

The CBTB family of electromagnetic axle brakes are specifically for use on battery-powered, dual-drive vehicles with capacities generally up to eight tons (17,900 lbs.). These advanced high-speed, high-torque brakes provide reliable emergency and parking brake functionality and allow for increased maximum vehicle speed and improved productivity.

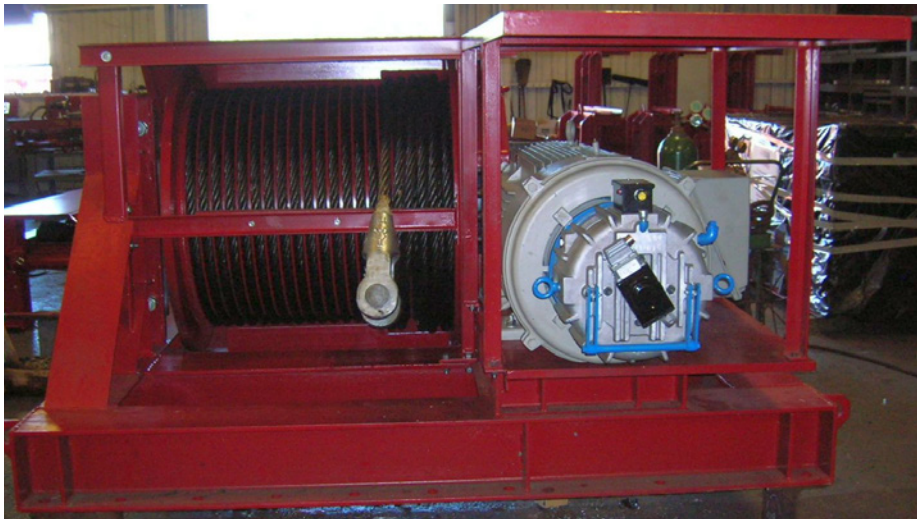
Proprietary W134 nonstick dry friction material, designed and manufactured in-house, is available on PK and CBTB models for increased high-capacity braking requirements at very high speeds. The linear speed of the friction material determines the speed limit, certain brakes and design sizes have been functionally tested at speeds of 12,000 rpm.

Force Control MagnaShear Brakes Provide Conveyor and Mining Solutions

MagnaShear motor brakes, which provide a secure, no-maintenance, no-adjustment, holding brake solution for mining conveyor applications were recently featured at Minexchange 2023.

In addition to holding brakes, MagnaShear are ideal for mining applications where the motor is stopped, or reversed, each cycle such as loaders/unloaders, conveyors, rail car spotters and dumpers, overland and internal tripper cars, rotary coal sweep samplers, and more.

These proven motor brakes are available to accommodate a wide range of applications. Spring set torque ratings from three to 1,250 foot-pounds are available. The MagnaShear motor brakes can be sized to the correct torque value independent of the motor frame size or horsepower by



MagnaShear brakes are ideal for conveyors, rail car spotters and dumpers, overland and internal tripper cars, rotary coal sweep samplers, and more.

Magnashear brakes working in a mining application.

changing the combination of springs and friction discs.

MagnaShear motor brakes feature a "quick mount" feature for quick and easy mounting to drive motors in NEMA frame sizes 56 to 449 or some IEC frame motors. They are shipped ready to install, with no assembly or adjustments required.

MagnaShear motor brakes can be furnished as a complete motor and brake assembly (assembled brake motor), or to mount on a machine frame or other special mounting configuration.

These proven motor brakes are totally enclosed from outside contaminants, with seal integrity for harsh and washdown environments. A modular design/assembly allows for ease of servicing and maintenance.

Hazardous duty units for class II, Group a, b, c, d, e and f are also available, as well as low temperature or Artic duty down to –40 degrees.

The totally enclosed MagnaShear motor brakes are impervious to moisture, dirt and dust that is common in mining applications, as well as concrete block plants, asphalt shingle manufacturing, bulk material handling, forest products manufacturing, and more.

forcecontrol.com

Bosch Rexroth Offers Drive Solutions from Hägglunds

The products and solutions Hägglunds recently displayed at Min-exchange 2023 leverage the unique characteristics of hydraulic direct drive technology—delivering power directly to the drive shaft with full torque from zero speed and protection from shock loads—to maximize the efficiency and uptime of conveyors, feeders, crushers, drums, bucket wheel reclaimers, kilns and more.

Torque Control: Direct drives with low speed and high torque can provide full torque from standstill, without time restrictions. Hägglunds hydraulic direct drives can operate continuously throughout their power range up to their rated torque, from zero to full speed.

Start-Stop-Reverse: A Hägglunds hydraulic direct drive reacts especially quickly due to its very low moment of inertia. They can switch automatically from driving to braking mode, and the direction of rotation can be switched quickly by changing the direction of the oil flow.

Shock Load Resistance: Shock loads can damage critical equipment and lead to major unplanned downtimes. With direct drive motors applying power directly to the core of conveyors, crushers and feeders, the direct drive offers a solution without mechanical play and with a low moment of inertia so it can easily withstand vibrations, external shock loads and changing load directions.

Fusion Direct Hydraulic Drive: Released in 2022, Hägglunds Fusion won industry recognition two times. The Fusion is a unique drive system that puts everything on the torque arm, from the hydraulic motor and pumps to the cabinet that houses them, making high torque and total reliability available from a single unit – in a footprint that was previously unthinkable.

Atom Hydraulic Motor: Combining the right size with Hägglunds performance, it offers the right fit for mining applications where both compact size and high-power density are required. With a maximum torque of up to 13.6 kNm and a specific torque of 40 Nm/bar, the Hägglunds Atom hydraulic motor can supply maximum power of 394 kW, outstripping other motors in its class.

CB Direct Drive Motors: Tough and rugged with a wide range of sizes and displacements, the Hägglunds CB provides the right solution for many heavy-duty applications, such

Multiple Hägglunds direct drive systems offer solutions for key mining applications.

as shredders, feeders and roll mills. It combines space-saving designs with a wide range of sizes and displacements.

Rineer Motors: Bosch Rexroth's Rineer motors offer the highest power density with maximum torque, as well as robustness, even under the most adverse climatic conditions and high dirt loads. Rineer motors are frequently used in the mining and construction sectors, on drilling and winch applications.

boschrexroth.com/en/us/hagglunds/

Dana Launches Driveline Solutions for Telehandlers

Dana Incorporated recently announced the launch of a hydrostatic driveline for telehandlers in North America. The system's modular architecture enables customers to easily transition to a hydrogen or battery-electric vehicle design.

Developed for telehandler applications lifting up to 12,000 pounds, Dana's new driveline comes equipped with a compact Spicer 312 dropbox for high-power hydrostatic motors. This new hydrostatic dropbox functions as a continuously variable transmission without torque interruption and delivers enhanced performance with precise movements at low speeds, reduced fuel consumption, and an integrated spring applied hydraulic release parking brake.

The transmission is designed to be coupled with the field-proven Spicer 222 front and rear heavy-duty axles, which each feature a limited-slip differential and provide the customer with maintenance-free brakes. The complete driveline system is optimized for efficiency as well as noise, vibration, and harshness.

"Dana has more than 40 years of expertise designing and implementing hydrostatic transmission solutions for diverse applications across the off-highway market," said Jeroen Decleer, senior vice president of Dana Off-Highway Drive and Motion Systems. "Our new hydrostatic driveline offers operators an easy-to-use solution with increased performance and efficiency at low speeds. This makes it an ideal fit for use in the North American telehandler market and its modular approach gives customers the flexibility to make the transition to a zero-emissions solution."

In order to support the industry's transition to zero-emission vehicles, Dana optimized the axles and driveline system for efficiency to support a variety of architectures, allowing customers to retain the same driveline solution while choosing between implementing a hydrostatic dropbox or electrically driven design.

From single-and two-speed dropboxes to shift-on-fly and powersplit transmissions, Dana offers a complete range of hydrostatic transmissions that enable customers to leverage the best solution for their specific vehicle's duty-cycle requirements.

In addition, Dana is investing in updated drive and motion technologies for traditional and electrified construction machinery, including mini excavators, mobile elevating work platforms (MEWPs), and crawler cranes.

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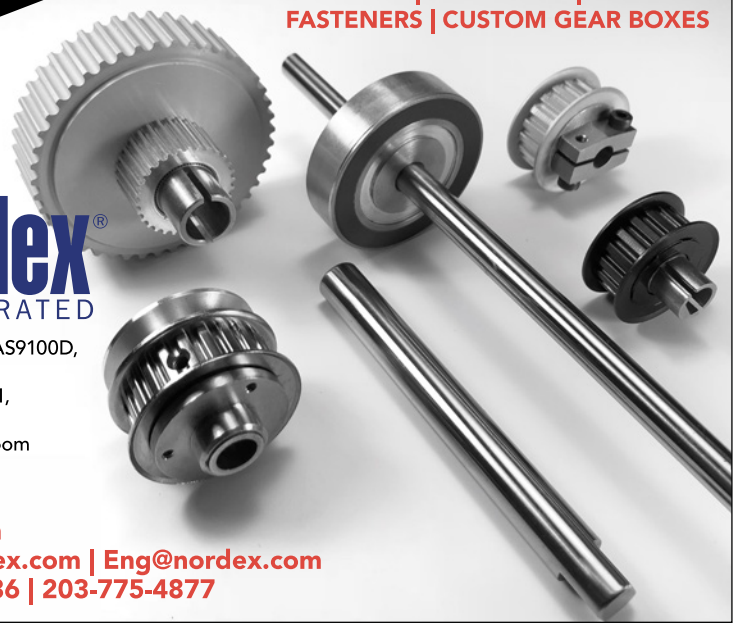

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Ball Bearing Inner Ring Fits and Creep

Norm Parker, Technical Fellow, Stellantis

Figure 1—Outer ring creep of differential tapered bearings.

I think I spend more time talking about ball bearings today than at any other time in my career. Ball bearings have always had a large place in automotive, but not typically in high demand positions—other than a few niche areas. High demand positions, such as axles and planetaries, were typically reserved for tapers, needles and cylindricals. The landscape is changing quickly. Along the rotor shaft of an electric powertrain, ball bearings and cylindricals are the most popular choices to handle the high-speed demands, often accompanied with high load demands from the first reduction gearset. The cycle count demands of these bearings are like traditional valvetrain bearings. Whenever the vehicle is moving, these bearings are in motion and taking load. Depending on the gear ratio and type of vehicle, cycle counts north of a billion are not out of the question. Over the life of a heavily loaded bearing of any sort, some amount of turning on the shaft and housing are not uncommon. Light indications of turning that aren't plowing and damaging material are generally considered harmless. If the turning is substantial, it can create heat, wear, and become a real issue. This annoying reality that we must deal with is referred to as creep. There are a few different mechanisms that can cause creep which we will cover in depth another time. Much of the literature you will read only talks about outer ring creep, but inner ring creep is just as common and can be more troublesome.

The ball bearing design process starts with inner ring fits and if you mess this part up in the beginning, it can be difficult to fix later.

In every bearing catalog, you will start with a table that looks something like this:

Table 9-1 Load characteristics and fits

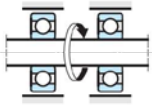
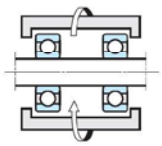
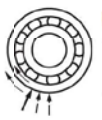
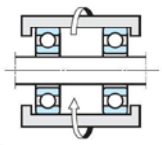
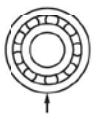
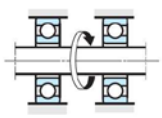
Rotation pattern	Direction of load	Loading conditions	Fit		Typical application
			Inner ring & shaft	Outer ring & housing	
 Inner ring : rotating Outer ring : stationary	 Stationary	Rotating inner ring load	Interference fit necessary	Clearance fit acceptable	Spur gear boxes, motors
 Inner ring : stationary Outer ring : rotating	 Rotating (with outer ring)	Stationary outer ring load	(k, m, n, p, r)	(F, G, H, JS)	Greatly unbal-anced wheels
 Inner ring : stationary Outer ring : rotating	 Stationary	Stationary inner ring load	Clearance fit acceptable	Interference fit necessary	Running wheels & pulleys with stationary shaft
 Inner ring : rotating Outer ring : stationary	 Rotating (with inner ring)	Rotating outer ring load	(f, g, h, js)	(K, M, N, P)	Shaker screens (unbalanced vibration)
Indeterminate	Rotating or stationary	Indeterminate direction load	Interference fit	Interference fit	Cranks

Figure 2—JTEKT Co. Cat B2001E-3 Ball and Roller Bearings Table 9-1 p.A80

If you are not used to the nomenclature, gearboxes of any sort have a rotating inner ring load (the load is being delivered by the shaft), opposed to a wheel bearing which has a rotating outer ring load. This takes us to the first row of the table (above) which calls for an interference fit on the inner ring and a clearance fit on the outer ring. I get asked frequently why we have a clearance fit on the outer ring and won't it spin in the housing? For a non-sealed bearing in an oil fed system, the answer is, you may see some light evidence of turning, but not enough to move material and/or create any type of damage. The reason why this is the case is because the bearing is usually loaded, pressing the outer ring into the housing. When we go from drive to coast or regeneration, the bearing load is briefly lifted, and the bearing may turn a little during this transition time, but no load means no damage. When the bearing is loaded, it is only the tractive force of the rollers trying to move the outer ring. There are times when this still can be an issue, but most of the time it is not. Inner rings aren't always so obvious. I have had rings turn that had no business turning. The loads were light, the fits were substantial. Or other times, the loads were substantial, but the press fits were outrageously high. Sometimes you simply cannot get it to completely go away. It is good to have a pre-established plan for what to call acceptable and not acceptable. Many bearing engineers like the crude fingernail test. If you can feel it with your fingernail, it's not great. First, determine if the bearing has been turning. On a ball bearing, there will often be some obvious abrasion on the inner ring or polishing of the surfaces. After test, if the bearing bore, shaft, or parts of the bearing seem unusually shiny, it likely has been turning. The photograph (third column, top) is a taper, but was a good example of a bearing that was obviously turning, but didn't damage any mating components.

Tested Bearing: Mirror surface, reduced grind lines: Bearing has been turning

New Bearing: Dull surface, non-reflective, covered with grind lines

Then determine the level of damage. If the bore is black or heavily scored, you probably need to revisit your fits. If it is like the bearing photograph (third column, bottom), some light turning, but no damage—cannot feel anything with your fingernail, you may be ok if it was a severe test and you don't anticipate it getting any worse.


OBJECTIONABLE: Heavy thermal staining. Heavy wear lines.


OBJECTIONABLE: Heavy record lines, heavy wear


Light thermal marks at edges. Light indications of turning. No tactile damage. Possible pass.

I love having a fit chart on hand at all times. One easy point to remember is that an H fit is a line to line fit for both shaft and housings. As you move up the alphabet, the fits get tighter. The number

represents the IT (international tolerance) band for each fit. A 6 might have a 12 µm tolerance where 8 might have a 25 µm tolerance—all depending on the specific size.

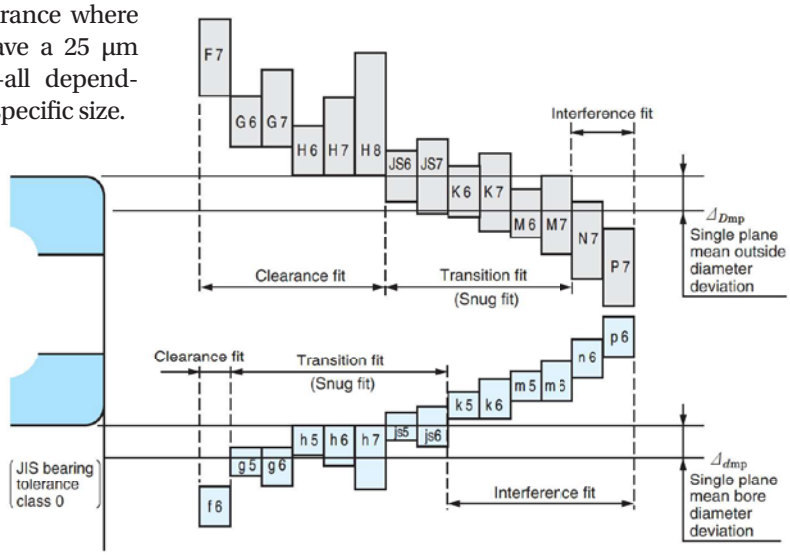


Figure 3—JTEKT Co. Cat B2001E-3 Ball and Roller Bearings Figure 9-1 p.A80

Around this same area in the catalog, there will be a more detailed chart with the most important disclaimer you are going to see. This chart only applies to solid shafts. That is not to say if you have a hollow shaft, the chart is useless. Very generally, I like to assume a 1 class higher fit for hollow shafts. If the chart says a k shaft for instance, I will often start with an m fit and seen how the math works out.

Table 9.2 Fits of Radial Bearings with Shafts

Load Conditions		Examples	Shaft Diameter (mm) Ball Brgs	Cylindrical Roller Brgs, Tapered Roller Brgs	Spherical Roller Brgs	Tolerance of Shaft	Remarks
Radial Bearings with Cylindrical Bores							
Rotating Outer Ring Load	Easy axial displacement of inner ring on shaft desirable.	Wheels on Stationary Axles	All Shaft Diameters			g6	Use g5 and h5 where accuracy is required. In case of large bearings, f6 can be used to allow easy axial movement.
	Easy axial displacement of inner ring on shaft unnecessary	Tension Pulleys Rope Sheaves				h6	
Rotating Inner Ring Load or Direction of Load Indeterminate	Light Loads or Variable Loads ($<0.06C_r$(1))	Electrical Home Appliances Pumps, Blowers, Transport Vehicles, Precision Machinery, Machine Tools	<18	—	—	js5	
			18 to 100	<40	—	js6 (j6)	
			100 to 200	40 to 140	—	k6	
			—	140 to 200	—	m6	
	Normal Loads (0.06 to $0.13C_r$(1))	General Bearing Applications, Medium and Large Motors(3), Turbines, Pumps, Engine Main Bearings, Gears, Woodworking Machines	<18	—	—	js6 or js6 (j5 or j6)	k6 and m6 can be used for single-row tapered roller bearings and single-row angular contact ball bearings instead of k5 and m5.
			18 to 100	<40	<40	k5 or k6	
			100 to 140	40 to 100	40 to 65	m5 or m6	
			140 to 200	100 to 140	65 to 100	m6	
			200 to 280	140 to 200	100 to 140	n6	
			—	200 to 400	140 to 280	p6	
			—	—	280 to 500	r6	
			—	—	over 500	r7	
	Heavy Loads or Shock Loads ($>0.13C_r$(1))	Railway Axleboxes, Industrial Vehicles, Traction Motors, Construction Equipment, Crushers	—	50 to 140	50 to 100	n6	More than CN bearing internal clearance is necessary.
			—	140 to 200	100 to 140	p6	
			—	over 200	140 to 200	r6	
			—	—	200 to 500	r7	
Axial Loads Only			All Shaft Diameters			js6 (j6)	—
Radial Bearings with Tapered Bores and Sleeves							
All Types of Loading		General bearing Applications, Railway Axleboxes	All Shaft Diameters			h9/IT5(2)	IT5 and IT7 mean that the deviation of the shaft from its true geometric form, e. g. roundness and cylindricity should be within the tolerances of IT5 and IT7 respectively.
		Transmission Shafts, Woodworking Spindles				h10/IT7(2)	

Notes (1) C_r represents the basic load rating of the bearing.
(2) Refer to Appendix Table 11 on page C22 for the values of standard tolerance grades IT.
(3) Refer to Tables 9.13.1 and 9.13.2 for the recommended fits of shafts used in electric motors for deep groove ball bearings with bore diameters ranging from 10 mm to 160 mm, and for cylindrical roller bearings with bore diameters ranging from 24 mm to 200 mm.
Remarks This table is applicable only to solid steel shafts.

At this point, you'll have a decent guess for the bearing fit. From the chart (below left) for a 25 mm shaft with moderate loads, you will often find yourself in the k5, k6 area and thinking about the m fits for a hollow shaft. This is where the important part starts. When we press fit a bearing on a shaft, the bearing inner ring is going to expand. We never want the bearing internal clearance to go to zero and into radial preload. Ball bearings can handle a very small amount of radial preload—5–10 µm—but this should not be built into the operating design. This might be a consideration for very extreme conditions, such as running a sustained high-speed test where the inner ring temperature might be ~ 20°C hotter than the outer ring and could allow 5 µm of preload for that specific test. We do not want radial preload during normal operating conditions. It generates huge internal loads to the bearing and increases operating temperature which further increases internal loads. This can develop into a spiral that results in failure. Regardless of our fit, the bearing internal clearance must be designed to match at this point. Let's talk about nightmare scenario one. You are purchasing the motor and shaft that you are pressing your bearing onto. You find late in testing that the bearing is spinning too hard and needs to have the shaft fit increased. The motor supplier won't cha-nge their dimension without revalidating. The bearing supplier will adjust the clearance, but puts you into a separate manufacturing run which increases the cost. You are in trouble. With this scenario in mind, it might sound tempting to increase your fit as much as possible, but there are two roadblocks on that side as well. First, there is a hoop stress limitation for the bearing inner ring to avoid risking cracking the ring. The typical guideline for this 120 MPa for ball bearings—though numbers up to 150 MPa are not uncommon. The second roadblock is serviceability. Bearings that are around 150 MPa or more are incredibly hard to remove without damage (usually from cutting them off). We find our design window getting smaller. We need to know how much fit we really need. This is based on the operating load and a simple equation buried in my favorite catalog, the NSK *Technical Report* (Fig. 4, page 41).

3.2 Required effective interference due to load

The magnitude of the load is an important factor in determining the fit (interference tolerance) of a bearing.

When a load is applied to the inner ring, it is compressed radially and, at the same time, it expands circumferentially a little; thereby, the initial interference is reduced.

To obtain the interference reduction of the inner ring, **Equation (1)** is usually used.

$$\left.\begin{aligned} \Delta d_F &= 0.08\sqrt{\frac{d}{B}}F_r\times10^{-3} && \text{(N)} \\ &= 0.25\sqrt{\frac{d}{B}}F_r\times10^{-3} && \text{\{kgf\}} \end{aligned}\right\} \quad \cdots\cdots (1)$$

where Δd_F: Interference reduction of inner ring due to load (mm)
d: Inner ring bore diameter (mm)
B: Inner ring width (mm)
F_r: Radial load (N), {kgf}

Therefore, the effective interference Δd should be larger than the interference given by **Equation (1)**.

The interference given by **Equation (1)** is sufficient for relatively low loads (less than about 0.2 C_{0r} where C_{0r} is the static load rating. For most general applications, this condition applies). However, under special conditions where the load is heavy (when F_r is close to C_{0r}), the interference becomes insufficient.

For heavy radial loads exceeding 0.2 C_{0r}, it is better to rely on **Equation (2)**.

$$\left.\begin{aligned} \Delta d &\geqq 0.02\frac{F_r}{B}\times10^{-3} && \text{(N)} \\ &\geqq 0.2\frac{F_r}{B}\times10^{-3} && \text{\{kgf\}} \end{aligned}\right\} \quad \cdots\cdots (2)$$

where Δd: Required effective interference due to load (mm)
B: Inner ring width (mm)
F_r: Radial load (N), {kgf}

Figure 4—NSK Technical Report Cat. No. E728g p. 64

Let's apply this to a standard 6205 running up to 50 percent of the dynamic load rating.

Dimensions	
Bore diameter	25 mm
Outside diameter	52 mm
Width	15 mm

Performance	
Basic dynamic load rating	14.8 kN
Basic static load rating	7.8 kN
Limiting speed	18 000 r/min
Reference speed	28 000 r/min

Fifty percent load falls under equation 2. $\Delta d \geq 0.02$ (7.7 kN/15 mm) = 10.2 µm. This is the interference fit needed to avoid creep at this load. Even though this formula does not specify hollow or solid shafts, I have found it sufficient for both and usually higher than the table recommendations. This is a little higher than an m5 fit which is 8–17µm for a 6205. The very next step from here is calculating the hoop stress for the fits at the upper end. Most people do this through bearing software or FEA analysis, there are a couple of free online bearing calculators on the bearing manufacturers sites and there is a cumbersome manual calculation also found in most bearing catalogs. Secondly, you need to talk to the bearing supplier about what your options are and what clearances you should be running. What is going to cost you pennies and what is going to cost you dollars? And finally, if you haven't already done this, what load do you really need to protect for? Hopefully I have done my job and convinced you that not every micron of turning needs to be stopped. How do your calculations change if you allow the top 10 percent of the loads go above the creep calculation? How much time are you really going to spend at 50 percent, etc.?

In our next post, we will finish out this example for completely defining the fit and internal clearance along with talking about outer ring creep.

PTE

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A Model for Considering Wheel Body Deformation in Tooth Contact Load Distribution

Benjamin Abert and Dr. Georg Hammerl

Introduction

Current legislation and customer concerns about climate change demand drives with a special focus on efficiency. General trends are starting to focus on energy savings, and customers often use total cost of ownership as a deciding factor when selecting new drives.

In addition to the influences of the gear geometry, for example as described by Wimmer (Ref. 1), lightweight construction also plays an increasingly important role. Targeted lightweight gear wheel design can reduce the rotating mass, which directly reduces the energy required by the drive unit during acceleration or braking. The following formula (1) for determining the rotational energy E_{rot} measured in [*J*] demonstrates the potential for energy savings:

$$E_{rot} = \frac{1}{2} * J * \omega^2 = \frac{1}{2} * \int r^2 dm * \omega^2 \qquad (1)$$

J represents the mass moment of inertia in [kg*m²], and ω describes the angular velocity in [1/s]. For cylindrical wheel bodies, this results in:

$$J_{cyl} = \frac{1}{2} * m * r_o^2 = \frac{1}{2}\rho(\pi * r_o^2 * b) * r_o^2 = \frac{1}{2}\rho * \pi * b * r_o^4 \qquad (2)$$

where ρ represents the density in [kg/m³], b the width in [m], and r_o the outer diameter of the wheel body in [m]. The outer radius r_o is factored to the fourth power in the inertia calculation and is therefore particularly suitable for reducing the energy expended for acceleration or braking. A smaller gear would serve the same purpose, but this is not always possible as the transmissible torque may no longer be sufficient or the transmission ratio may have specific requirements. However, r_o^4 can be substituted with r_o^4-r_i^4, where r_i^4 represents the inner diameter of the wheel body. In other words, the overall amount of wheel body material can be reduced. This brings both cost savings from lower material consumption and energy savings during acceleration and braking. This simple consideration makes it clear that the gear rim thickness should be minimized for the most efficient acceleration. However, this also presents limitations, as less material under the teeth reduces the stiffness, which leads to changes in the load and pressure distribution and in the excitation spectrum. For example, holes in the wheel body have been shown to influence the excitation (Ref. 2).

Therefore, the wheel body must be considered in the design of gear modifications, as it has a significant influence on the gear modification itself, the noise excitation, and also on the tooth root stress in extreme cases. The following paper will introduce a method that makes it possible to consider the influence of the wheel body geometry on the gear. As the influence of the wheel body on the tooth root stress only has a significant impact on the product design in extreme cases, such as in aviation, this will not be considered in detail.

Today, complex flexible structures are calculated using the finite element method (FEM). Here, the mechanical equations are solved (in a weak form, in an integral sense) on powerful computers/clusters using a discretized geometry. The tooth contact is also frequently modeled and calculated with a rolling through of at least one mesh. This method makes it possible to consider any mechanical effects, such as of the wheel bodies. However, these calculations are very slow (calculation times > 1 hour are not uncommon), especially if the tooth contact is also modeled. Furthermore, identifying solutions for contact problems is not a trivial task, and the calculation may terminate unexpectedly if the parameters are not selected appropriately.

Fast solutions are preferable, especially in the early design phases. Many calculation tools use an approach based on Weber-Banaschek (Ref. 3). The results of these simulations have been validated many times and have been used in industrial applications for decades. Thus, it is obvious that the influence of the wheel body in the stiffness calculation according to Weber-Banaschek should be considered. The simple modeling of the gear using this analytical approach also does not lead to many errors. Even inexperienced engineers can produce reliable results, and specialized calculation engineers are not absolutely necessary.

To be commercially successful, new methods must meet the following requirements:

1. The method should be applicable in the gear design phase. This requires calculation times < 10 seconds.
2. The results must be reliable, which presupposes that all relevant influences are considered.

The results of this paper have been simulated in the *FVA-Workbench* (Ref. 4) and compared with the results of research projects by the Drive Technology Research Association ("Forschungsvereinigung Antriebstechnik e.V", or FVA).

Background

Methods for Determining the Mesh Stiffness

In the *FVA-Workbench,* the local load is determined for each point on the flank using the influence coefficient method, with which the meshing force is distributed to individual points for each meshing position along the contact lines. The local stiffness at these points can be determined using two different methods:

Determination of the Influence Factors According to Weber-Banaschek/Schmidt

In this approach, the local gear stiffness over the tooth depth is determined according to the Weber/Banaschek method (Ref. 3). The teeth are modeled as bending beams, with a cross-section that varies over the height. The deformation is influenced by the Hertzian contact, the shear deformation, and the clamping point of the tooth in the wheel body. The wheel body is considered as an elastic half-space. The majority of software packages use this method as the basic value for the gear stiffness, and it is also the foundation for the determining the gear stiffness according to DIN 3990 (Ref. 5) and ISO 6336 (Ref. 6). The additional change to the gear stiffness over the face width is considered using a plate model according to Schmidt (Ref. 7). This method is also implemented in the *FVA-Workbench* in the *RIKOR* (Ref. 8) and *DZP* (Ref. 9) calculation programs, and has been validated by both bench tests (Ref. 10) as well as decades of industrial application for the design of gear modifications. The advantage of this analytical formula-based method is that it produces reliable results for load distribution, noise excitation, and for the design of gear modifications with minimal calculation time.

The problem with previously available software-based implementations is that they only deliver precise results for the influence of cylindrical wheel bodies. The following solution will demonstrate how the analytical calculation of the influence factors can be extended to include detailed wheel body deformation calculated using FE methods, without significantly increasing the calculation time.

Determination of the Influence Factors Using an FE Approach

In this approach, the tooth deformation influence factors can be calculated using FEM. Here, both the gear and the wheel body are meshed. The mesh resolution is automatically determined according to a method developed in FVA Research Project 127 (Ref. 11), which is implemented in the *FVA STIRAK* calculation program and has also been validated in test bench trials and practical application. What is unique about this approach is that the parametric meshing is done using hexahedra for the tooth area to be evaluated and tetrahedra for the underlying wheel body. The two bodies are combined in the calculation process via mesh tying, also known as glued contact. This enables reliable FEM meshing of the gear, regardless of the complexity of the shape of the wheel body.

Similar to the Weber-Banaschek method, the influence factors are determined by applying a single load to discrete points and recording the deformation of the flank. For the FE calculation, these discrete points are the nodes of the FE mesh. The correct stiffness of the complete geometry, including the wheel body, is determined by superimposing the individual loads. The results show a slightly wavy surface for the pressure distribution. This can be smoothed by choosing a finer meshing resolution, but this increases the calculation effort.

The advantage of this FE-based approach is that the influence of the deformation of the wheel body is automatically considered. However, the calculation time is longer compared to the analytical approach.

Gear System Approach

To correctly determine the load distribution in cylindrical gear stages and design suitable gear modifications, all cross-influences between the machine elements of a complete gear system that are relevant for component deformation must be considered for the operating state to be calculated. The deformation behavior of the gearbox is represented in a complete stiffness matrix. The partial stiffness matrices of the individual components (casing, shafts, bearings, gears, couplings, etc.) are added to the complete stiffness matrix according to the method described in (Ref. 12). The deformation vector of the coupling points between the machine elements is determined by multiplying the inverted complete stiffness matrix by the load vector of the external loads.

To determine the partial stiffness matrices of each component, methods are used which deliver sufficiently precise determination of the deformations with a short calculation time. For example, the shafts are modeled in sections as classic Timoshenko beams. The bearing stiffnesses are determined according to (Ref. 13) based on the Hertzian contact deformation. FEM calculations are used for complex structural components such as the casing and planet carriers. A reduced stiffness matrix is determined for these components and then considered in the calculation. An example of this procedure is described in (Ref. 14). The system must be solved iteratively due to the non-linear behavior of the tooth contacts, the bearings in the gearbox, etc. This is done using the Newton method for iteration control.

How to Consider a Wheel Body

The gear stiffness from ISO 6336 (Ref. 5) is used throughout the mechanical system. This gear stiffness c_γ describes the deformation behavior of two gears in mesh, and the model includes a fully cylindrical wheel body.

The gear stiffness is linked with the shaft via a rigid lever arm. The stiffness of the shaft can be modeled as either a Timoshenko beam or as an FE structure. This modeling method is shown in Figure 1.

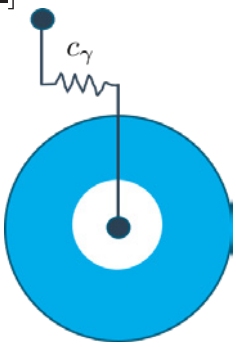

Figure 1—Analytical model using c_γ from ISO 6336.

In an intermediate step, the gear stiffness is initially considered using a modified stiffness which does not include the influence of the wheel body. This is designated as c_γ^{mod}, and the reduced stiffness of the wheel body is designated as k_{red}. The gear pair stiffness is then linked at the level of the virtual bending diameter of the wheel body according to (Ref. 15). This type of modeling is shown in Figure 2. To link the wheel body with the shaft, rigid rods are added which transmit the deflections of the shaft and the torsion of the wheel body.

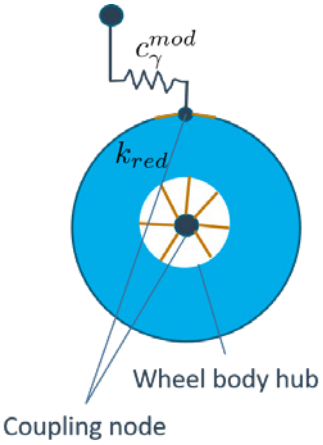

Figure 2—Integration of the reduced stiffness of the wheel body via a modified meshing stiffness.

In the following, a virtual node is introduced in the center of the hub and linked to the reduction point of the wheel body and the tooth pair stiffness. The connecting elements and the connection to the virtual node are rigid. This results in a system with identical mechanical behavior.

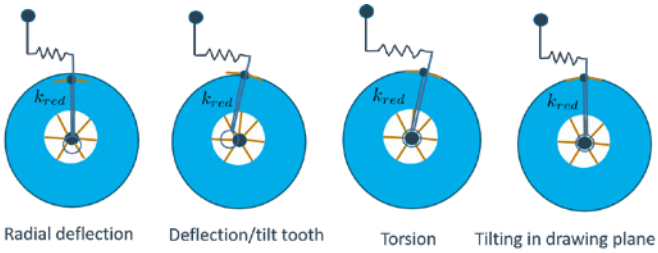

Figure 3—Possible deformation types of the model.

Considering the possible deformation cases shown in Figure 3, the advantages of this kind of modeling are clear. The common analytical models are limited to the bending of the tooth and the associated deformation of the cylindrical wheel body. In contrast, this model can represent all degrees of freedom. The radial deformation and its tilting in the drawing plane are important to consider for thin-walled structures, in particular.

To resolve the load distribution, reduction nodes are distributed at equidistant intervals across the common tooth width. The lever arms described above are applied at these reduction nodes. The shear influence in the wheel body is already fully considered via the static reduction.

The meshing of the surface is essential for the quality of the results. In particular, the distance between the nodes of the FE mesh and the reduction points has been observed to have an influence on the quality of the results. This imposes strict requirements on the quality and the resolution of the mesh. Special pre-processing of the CAD geometry of the wheel body makes it possible to fulfill these requirements.

Results and Discussion

The same model of a two-stage reducer gearbox, as typically used for electromobility, is used for all of the following analyses. The overall gear ratio of the gearbox is 1/7.76. The gearbox is driven with an input power of 100 kW at 5,000 min^-1. The input torque at a nominal speed is specified as 190 Nm.

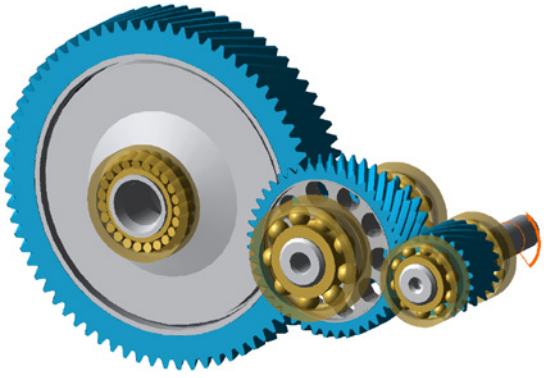

Figure 4—The model used for the following studies.

All of the following analyses focus on the input stage and describe its behavior. The gear data is summarized in Table 1:

	Sym.	Input stage [513]		Unit
		Wheel [516]	Pinion [517]	
Normal pressure angle	α_n	20		°
Helix angle at reference diameter	β	-30	30	°
Number of teeth	z	43	21	-
Center distance	a	75		mm
Normal module	m_n	2	2	mm
Transverse module	m_t	2.3094	2.3094	mm
Addendum modification coeff.	x	0.57179	0	-
Face width	b	25	32	mm
Tip diameter	d_a	105.591	52.497	mm
Transverse contact ratio	ε_α	1.301		-
Overlap contact ratio	ε_β	1.989		-
Total contact ratio	ε_γ	3.291		-

Table 1—Gear geometry.

The geometry of the wheel body is shown in Figure 5. The wheel body is fixed to the shaft via an interference fit. The geometry is largely determined by the outer diameter of the hub. The holes are positioned in the center between the outer diameters of the hub and wheel body to allow for holes with a maximum diameter.

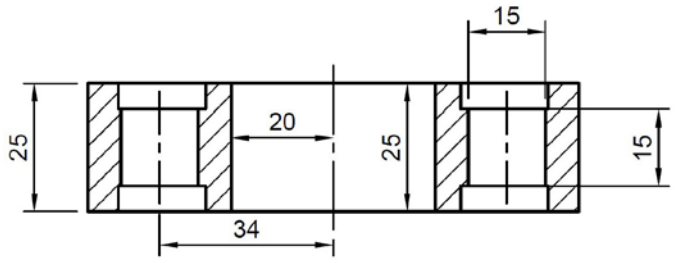

Figure 5—Illustration of the wheel body geometry.

The gear is modified to achieve uniform load distribution at nominal load. The full disc wheel body according to the Weber-Banaschek (Ref. 3) model is used as a reference. The 2D load distribution and the pressure distribution are shown in Figure 6.

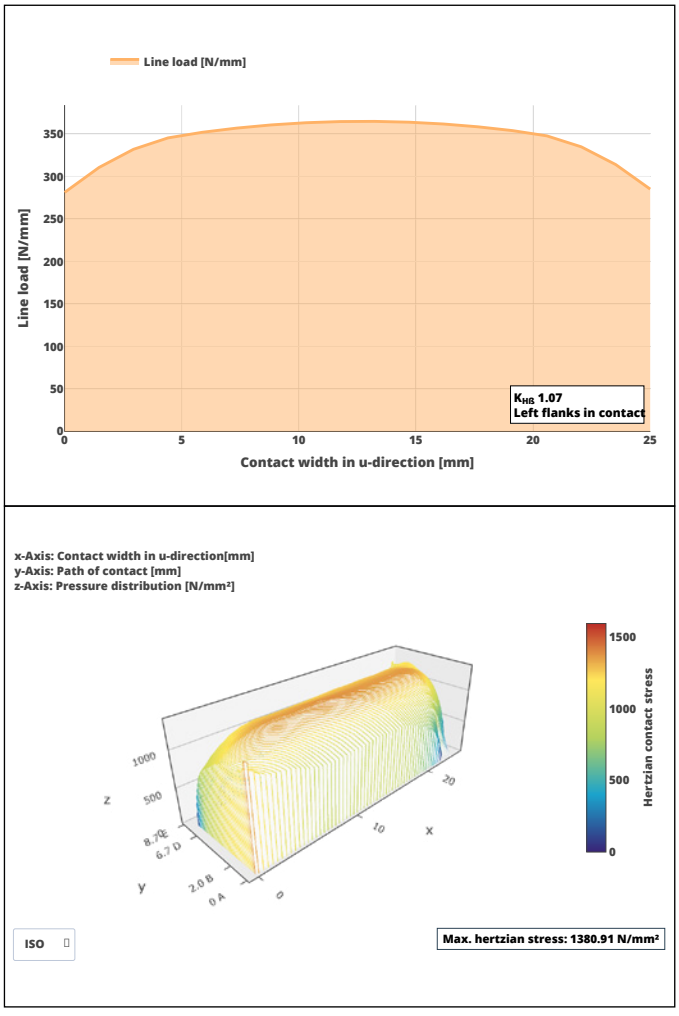

Figure 6—Loaded flank; load distribution over the tooth width (top), pressure distribution over the entire flank (bottom).

The applied gear modifications are specified in Table 2:

			Modification to:		
	Type of modification	**Symbol**	**Pinion**	**Wheel**	**Unit**
Face modifications	Helix angle modification	$C_{H\beta}$	17	-	µm
	Lead crowning	C_{β}	4	-	µm
	Circular end relief	C_{β}	3	-	µm
	Length of circular end relief	l_C	5	-	µm
Profile modifications	Symmetrical profile crowning	C_{α}	5	-	µm
	Circular tip relief	$C_{\alpha f}$	5	5	µm
	Length of circular root relief		3	4	µm

Table 2—Applied modifications.

This results in the flank and profile lines shown in Figure 7.

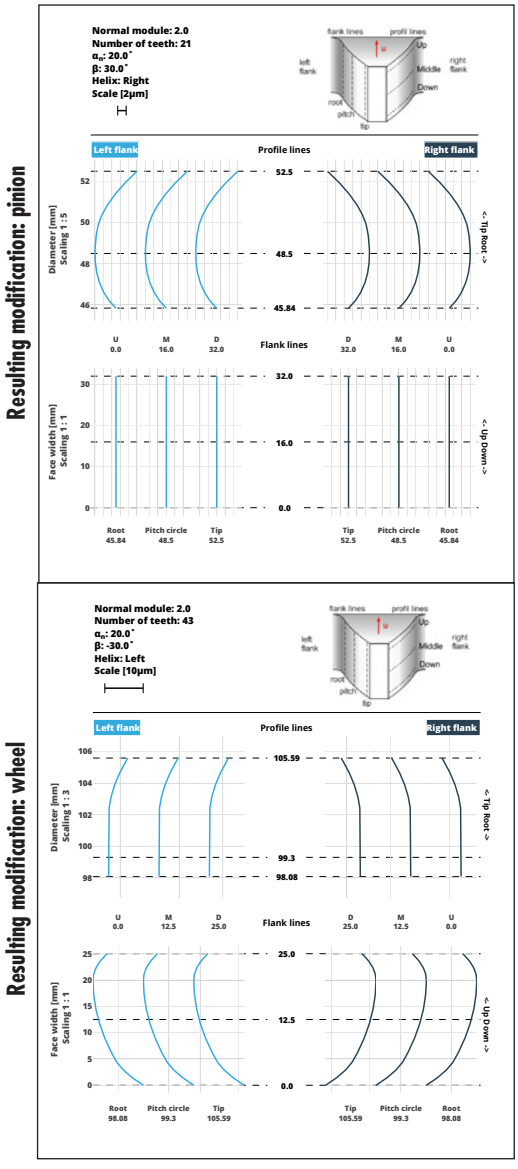

Figure 7—Resulting modifications for pinion and wheel.

Validation with Existing Models

First, the results of the cylindrical FE wheel body are compared with the results of the wheel body according to Weber-Banaschek. The width of the wheel body corresponds to the gear width. The diameter of the wheel body ends $3 * m_n$ below the gear.

In a pre-processing step, the wheel body is meshed with tetrahedra and the stiffness is determined using static reduction. The mesh details are listed in Table 3.

	Cylindrical gear wheel body [556]	Unit
FE mesh element quality assessment	All elements meet the quality criteria	-
Element type	Tetrahedron	-
Mesh type	Uniform	-
Element order	Quadratic	-
Number of elements	103857	-
Number of nodes	147865	-
Allow surface corrections	X	-
Defeaturing (relative to total size)	0	%

Table 3—Wheel body mesh details.

The results of the calculation are shown in Figure 8. The graph on the left shows the result with the wheel body according to Weber-Banaschek, the reduced FE stiffness is on the right. The results are qualitatively very similar, and there is no difference in the transverse load factor $K_{H\beta}$.

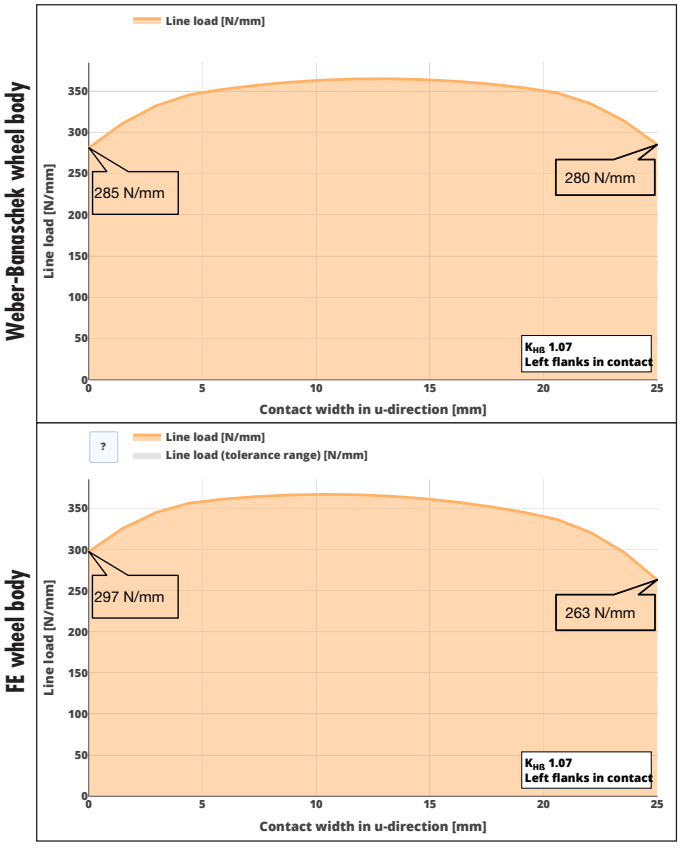

Figure 8—Comparison of the load distribution with (top) and without FE wheel body (bottom).

With the FE wheel body, a slight drop in the load (17 N/mm) can be observed at the right edge of the gear. At the left edge, the load increases by 12 N/mm. This indicates additional tilting in the tooth contact. Considering the deformations in the tooth contact, shown in Figure 9, it becomes clear that the additional tilting is caused by the lateral deformation of the wheel body.

Additional degrees of freedom are available with the FE wheel body, as shown in Figure 3. Due to the helical gears, an axial force acts on the gear mesh. In the axial direction, the wheel body behaves like a one-sided clamped cantilever. This deformation leads to additional tilting, in which the right side is pressed radially into the gear mesh and the left side is pulled out of the mesh. This increases the lateral deformation from 10 µm to 12.5 µm compared to the Weber-Banaschek model (Ref. 3).

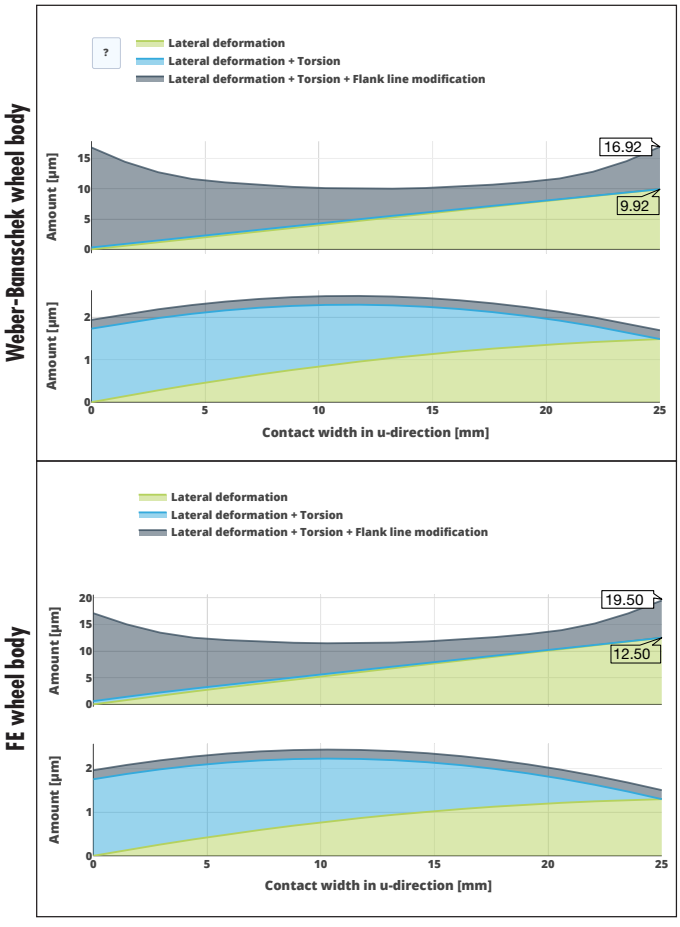

Figure 9—Deformation in tooth contact; with Weber-Banaschek (top) and FE wheel body (bottom).

The cylindrical wheel body is compared with an FE solution to validate the pressure distribution on the tooth flank over the gear mesh, using the *FVA STIRAK* program (Ref. 11) as a reference. For consistency, the meshing parameters defined in Ref. 16 are used for the FEM solution, as described in Table 4. To accelerate the calculation, only the teeth that come into contact are meshed. The total contact ratio determines the minimum number of teeth to be meshed.

Number of elements	Over the tooth height	16
	At tooth root	8
	Over the tooth thickness	8
	Common face width	32
Meshed teeth		4

Table 4—FE meshing parameters for the gear and wheel body.

The calculated pressure distribution for the analytical solution with reduced FE wheel body and the FE calculation with *STIRAK* are shown in Figure 10. Direct comparison shows that the pressure distributions are very similar. The maximum pressure for the *STIRAK* solution is 1440 N/mm², with 1381 N/mm² for the analytical solution. This difference is considered negligible.

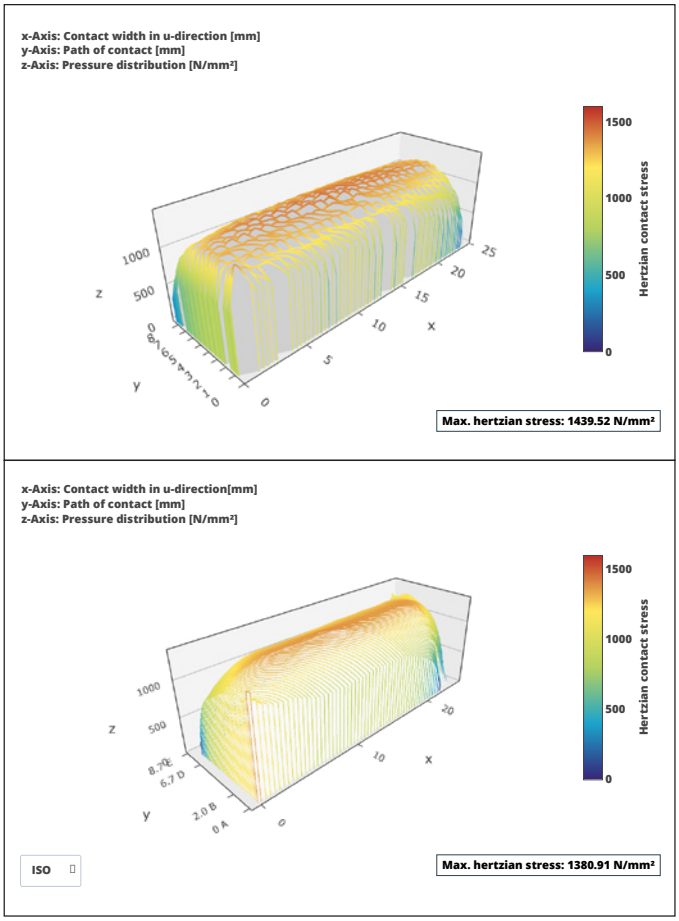

Figure 10—Pressure distribution comparison; pressure distribution with STIRAK (top), analytical pressure distribution with reduced FE wheel body (bottom).

Influence of the Wheel Body on the Gear Modification

The previous example clearly shows the influence that the axial force of a helical gear can have on the tilting of the wheel body. It can therefore be assumed that the web width will also have an effect on the gear modification. Thus, a wheel body will be calculated with a varying web width in this analysis. The geometry is documented in Table 5. As the load-carrying capacity of the wheel body cannot be considered with the available resources, it must be assumed to be sufficient. The wheel bodies are positioned such that the holes are always located directly under the gear for the calculation to maximize their effect.

#	Web width [mm]	Relative web width	Load distribution factor $K_{H\beta}$[-]	Wheel body weight [kg]	Relative weight change
1	25	100%	1.07	1.911	0%
2	25	100%	1.07	1.469	-23%
3	20	80%	1.12	1.239	-35%
4	15	60%	1.13	1.095	-43%
5	10	40%	1.15	0.952	-50%
6	5	20%	1.23	0.808	-58%

Table 4—FE meshing parameters for the gear and wheel body.

Variants 1 and 2 from Table 5 are cylindrical wheel bodies. Variant 1 corresponds to the calculation from the previous analysis; holes have been added to Variant 2 for additional weight savings. The holes are evenly distributed around the circumference and centered between the outer diameters of the wheel and hub.

Consideration of the relative weight differences between the variants clearly shows the potential of this type of wheel body. For example, a weight savings of over 60% can be achieved in Variant 6 with a web width of 5 mm.

Figure 11 shows the transverse load factor and the weight over the web width. As is to be expected, the graph shows that the weight decreases linearly with the web width. For the first two variants, it clearly shows that the holes do not have any effect on the transverse load factor. The transverse load factor increases as the web width is reduced. Surprisingly, moderate web widths only have a slight effect on the transverse load factor. In this case, the holes have no effect on the load distribution across the face width, as the wheel body was designed with a sufficiently thick gear rim. However, it can be assumed that the holes will have an influence on the transverse load factor with thinner gear rims.

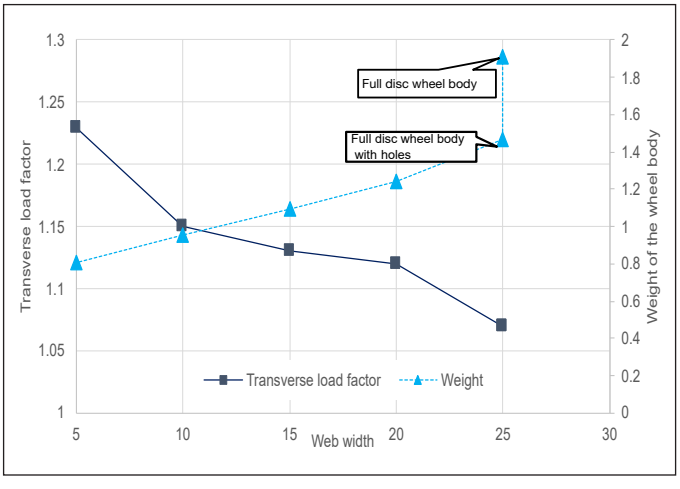

Figure 11—Transverse load factor and weight over the web thickness.

The additional deformation can be compensated for with a suitable helix angle modification. However, the modification to the drive and coast side flanks can differ significantly. It is essential that all relevant operating points are considered.

Influence of the Gear Body on the Noise Excitation

The previous results suggest that holes in the wheel body also have an influence on the tooth contact. Thus, the following will calculate four wheel bodies with different hole diameters. To more easily identify the influence of the holes in the evaluation, only four holes will be added. The analysis is performed using a wheel body with a web width of 15 mm to minimize its influence.

With this simulation technique, a rotating gear can be represented as rotation of the wheel body. The static reduction must be reperformed after each rotation. The rotational increment is one tooth.

To identify the influence of holes in the wheel body on the transmission error, a wheel body without holes is calculated in the first step. Figure 12 shows the transmission error over the angle of rotation of the wheel body. Qualitatively, it can be observed that the results fluctuate slightly. This is due to imperfections in the meshing. The transmission error curve shows a regular pattern with periodically recurring characteristics, as is to be expected from common excitation calculations. As long as no holes are included, the influence of the wheel body on the excitation is negligible. Harmonics can also be identified in the Fast Fourier Transformation (FFT) in Figure 13.

The meshing orders, marked as light blue lines, are particularly noticeable in the transmission error spectrum. The meshing orders are oriented to multiples of the number of teeth at the 43rd, 86th, 129th, and 172nd orders. Small amplitudes can also be seen between the first and 42nd orders due to harmonics in the transmission error and the meshing. These amplitudes occur when the reduction points are not located directly at a mesh node.

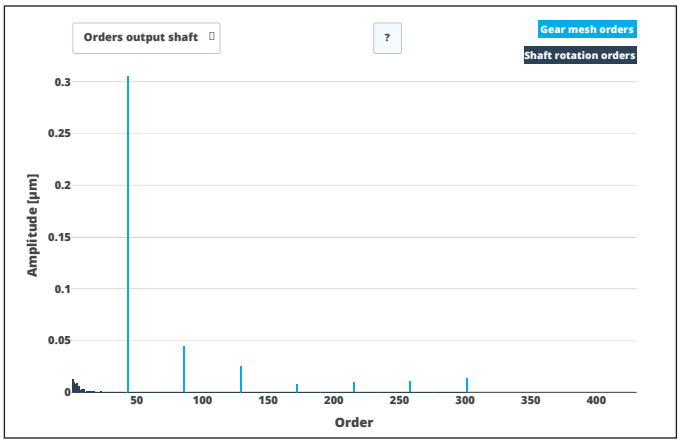

Figure 13—Transmission error spectrum of a wheel body without holes.

The following overview shows the excitation behavior for different hole diameters. The left column shows the transmission error, and the right column shows the spectra from an FFT.

Figure 14, which shows the transmission error over a single rollover and the associated FFT spectra, provides a summary of the calculation results. With regard to the transmission error, it can be seen that the magnitude of the oscillations increases with the hole diameter. The oscillation width increases more than nine-fold, from an initial 0.79 µm to 7.5 µm.

Looking at the spectrum of the transmission error, it shows that the tooth meshing orders are predominant with small hole diameters. As the hole diameter increases, additional orders can be seen in the spectrum. From a 5 mm hole diameter, the 4th order is clearly visible as an additional order with an amplitude of 0.1 µm. This order increases with the hole diameter. With a 20 mm hole diameter, the 4th order greatly exceeds the defined axis with 2.9 µm. Furthermore, it can be observed that sidebands appear at the tooth meshing frequencies as the hole diameter increases, with a spacing of ±4 orders. These orders can all be attributed to the number of holes and the hole diameter. It can therefore be stated that the hole diameter and the number of holes have a clear influence on the excitation behavior. If the holes become too large, the excitation of the hole dominates over the excitations from the gearing.

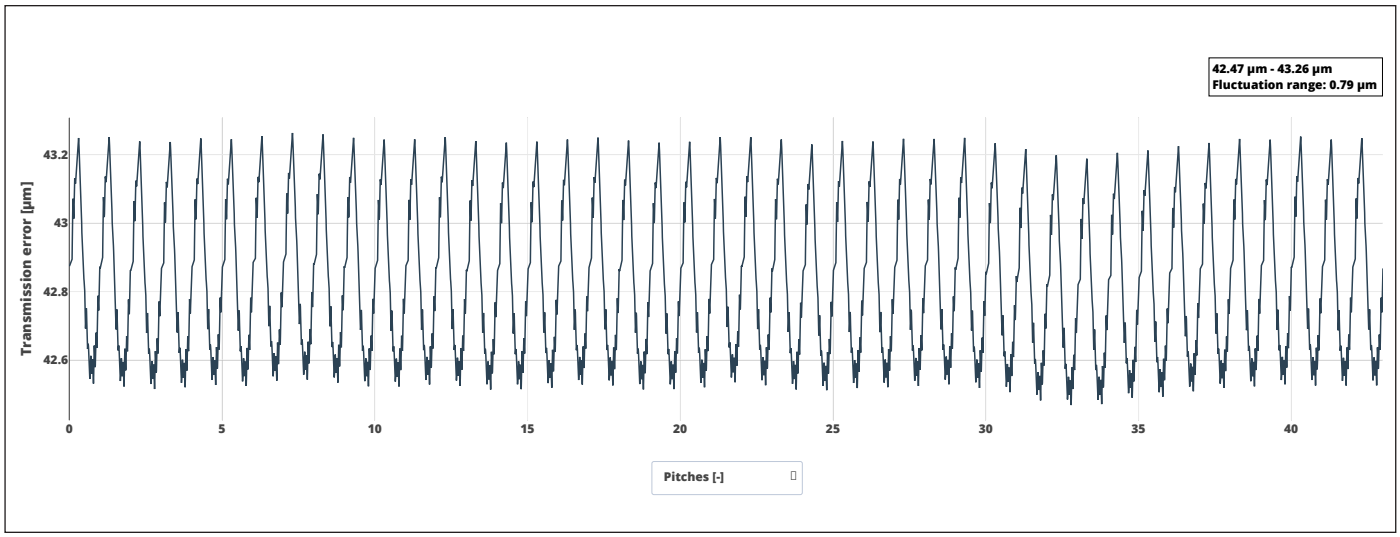

Figure 12—Transmission error of the gearbox input stage for a wheel body without holes.

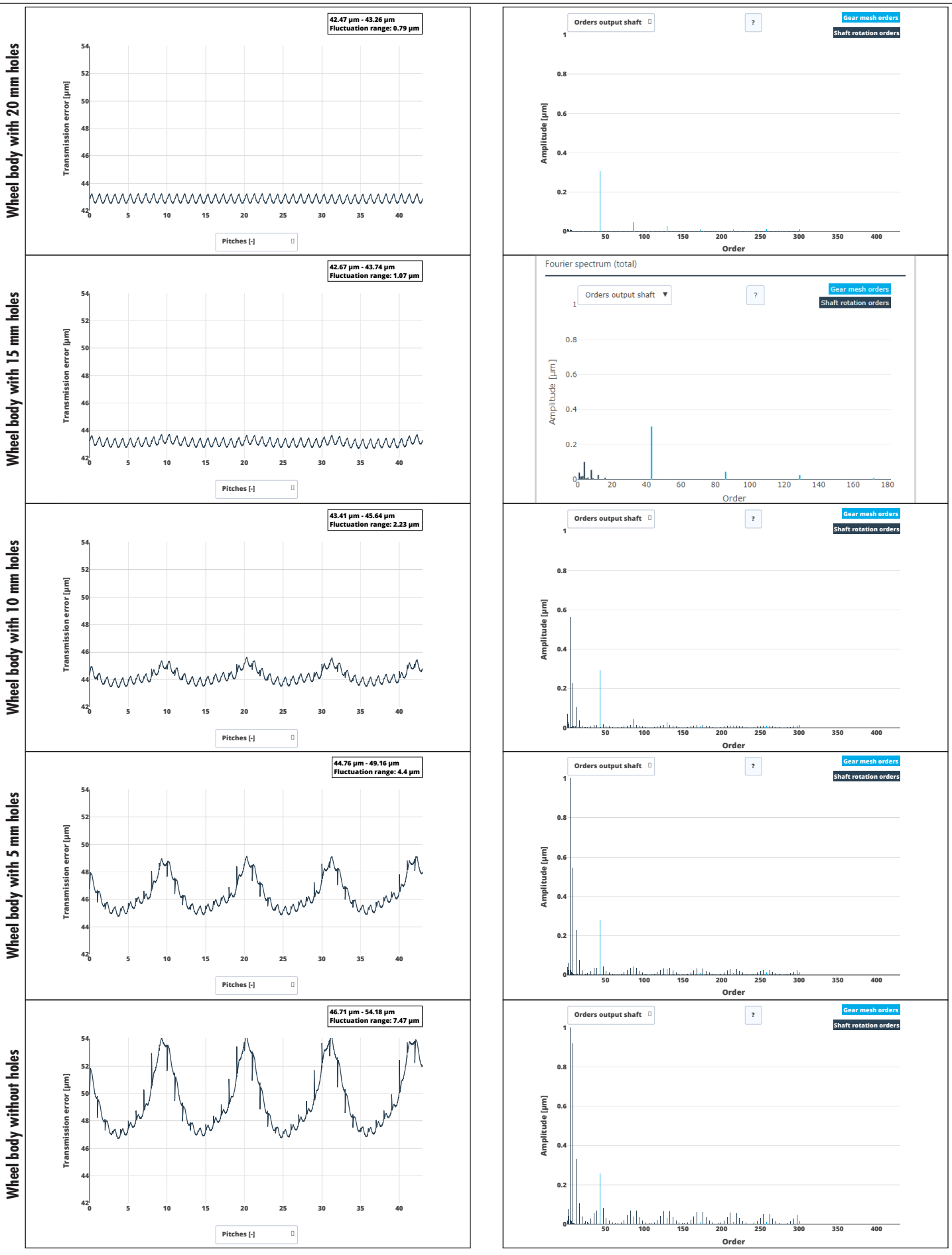

Figure 14—Overview of calculation results for hole diameters of 5 mm, 10 mm, 15 mm, and 20 mm.

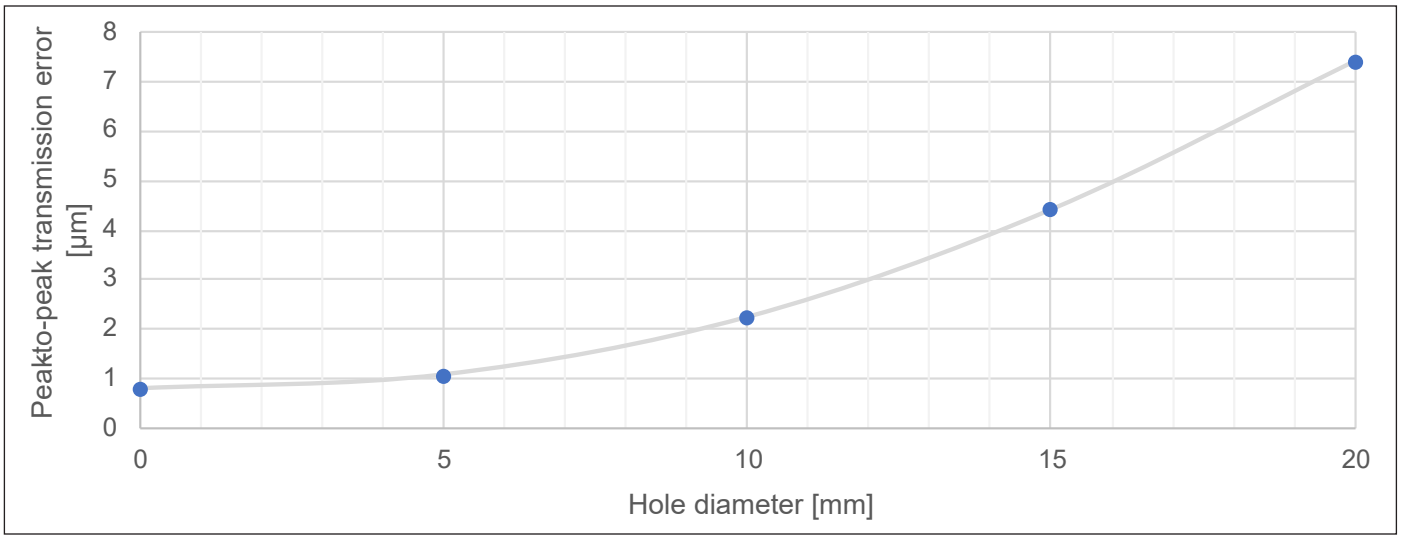

Figure 15—Influence of wheel body holes on the peak-to-peak transmission error.

In Figure 15, the ranges of variation of the transmission errors are evaluated. The fluctuation ranges are determined as maximum value—minimum value. The fluctuation range increases non-linearly with increasing hole diameter.

It can be seen that the wheel body has a strong influence on the excitation behavior. This influence should be taken into account when designing the gear teeth and should be simulated using suitable tools.

Conclusion and Future Work

This study presents a simulation method for considering complex wheel bodies in an analytical tooth contact model. The wheel body is considered using reduced FE stiffness. Reduction points are defined over the width and linked with the analytical gear.

For cylindrical wheel bodies, comparative calculations show fewer deviations from the expected results with the new method. This is due to the additional degrees of freedom in the FEM model. In the calculation with cylindrical wheel bodies, bending due to axial force in tooth contact could also be verified in addition to the deformation in tooth contact and the influence of the shaft-bearing system.

The influence of the web width on the tooth contact could also be demonstrated in the analysis of the face modification. The axial stiffness decreases with the web width, and the wheel body deforms under the load. As long as they are known, these deformations can be taken into account via additional helix angle modifications. In doing so, it is important to consider partial load conditions, as the lower loads result in smaller deformations. This is also principally the case without the wheel body; however, the wheel body introduces additional elasticities into the system which must be considered.

It could be demonstrated that the noise excitation is particularly affected by holes in the wheel body. Holes can be detected in the noise excitation and in the spectrum, almost irrespective of their size. The larger the holes, the greater their influence on the noise excitation. In particular, the low-frequency vibration components, such as the amplitudes from the hole, become significantly more important with increasing speeds in electrified powertrains. While lower speeds were common in the transmissions of internal combustion engines, higher speeds are frequently used in electric drives. For example, the speed4e concept drive (Ref. 17) uses 30,000 rpm on the drive side.

The heavy dependence on the finite element (FE) meshing quality poses a challenge, as the user must deal with different meshes and perform a convergence analysis to find the appropriate meshing quality. It would be preferable to specify a structured mesh on the surface at the transition between the FE wheel body and the analytical gear. This would ensure that the reduction points are always located on the nodes of the FE mesh.

Fast simulation is essential for being able to calculate the influence of the wheel body on the gear as early as possible in product development. With this simulation method the greatest effort is the static reduction, which must only be performed once. The calculation times were documented in the project and are summarized in Table 6. These speeds suggest that this method is suitable for product development.

Calculation step	Duration
Static reduction	30 seconds to 15 minutes, depending on the FEM meshing size
System calculation	Between 1 and 3 seconds, depending on the gearbox size

Table 6—Summary of calculation times.

In conclusion, it can be stated that the use of weight-optimized wheel bodies is possible and useful. However, this should be considered in gear calculations as early as possible, as the wheel body has an influence on both the load-bearing capacity and the noise behavior.

PTE

References

1. Wimmer, J. A., 2006, "Cylindrical Gear Load Losses: Design Influences, Efficiency Maximization, Tribology," Ph.D. thesis, TU Munich Gear Research Center (FZG).
2. FVA Research Project 484 V, Elastic Wheel Bodies, Forschungsvereinigung Antriebstechnik e.V. (FVA).
3. Weber, C. and Banaschek, K., Form Modification and Profile Relief of Cylindrical and Helical Gears. Antriebstechnik series of publications 11, Vieweg Verlag, Braunschweig.
4. FVA-Workbench Version 7.0 – Description of Modules (2022), FVA GmbH.
5. DIN 3990-1:1987-12: Calculation of load capacity of cylindrical gears; introduction and general influence factors, Beuth Verlag (1987).
6. ISO 6336-1:2019-11: Calculation of load capacity of spur and helical gears—Part 1: Basic principles, introduction and general influence factors, Beuth Verlag (2019).
7. Schmidt, G., 1972, "Calculation of the Rolling Contact Pressure of Helical Gears and Consideration of the Pressure Distribution," Ph.D. thesis, TU Munich Gear Research Center (FZG).
8. FVA Research Project 30 I–VII: Pinion Modification Program—RIKOR, Forschungsvereinigung Antriebstechnik e.V.
9. FVA Research Project 338 I–VII, Dynamic Tooth Force Program—DZP, Forschungsvereinigung Antriebstechnik e.V. (FVA).
10. FVA Research Project 592 I–II: Validation and Investigation of Application Limits of the FVA RIKOR Gear Program Based on Deformation Measurements, Forschungsvereinigung Antriebstechnik e.V. (FVA).
11. FVA Research Project 127 I–IX, STIRAK FEM Tooth Contact Analysis, Forschungsvereinigung Antriebstechnik e.V. (FVA).
12. FVA Research Project 571 I, Planetary Stage Load Distribution in the FVA-Workbench, Forschungsvereinigung Antriebstechnik e.V. (FVA).
13. Breuer, M., Theoretical and Experimental Determination of Rolling Bearing Stiffness, VD Progress Reports, Series 1, No. 241 (1994).
14. FVA Research Project 711, Integration of Elastic Casing Structures in Gearbox Design with RIKOR and Visualization of the Entire Transmission System in the FVA-Workbench, Forschungsvereinigung Antriebstechnik e.V. (FVA).
15. Wikidal, F., 1998, "Calculation of the Flank Pressure of Cylindrical and Helical Gears Under Consideration of Load and Production-Related Deviations," Ph.D. thesis, TU Munich Gear Research Center (FZG).
16. FVA Research Project 892, FE Calculation of Plastic Gears in the FVA-Workbench, Forschungsvereinigung Antriebstechnik e.V. (FVA).
17. Speed4E project website: speed4e.de/Joomla/index.php/e

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COLLABORATE TO EXPAND AUTOMATION ACROSS THE UNITED STATES

Two of the global manufacturing industry's premier organizations, AMT—The Association For Manufacturing Technology and Mesago, a subsidiary of Messe Frankfurt Group, have announced a collaboration to create the Automation Sector at IMTS—The International Manufacturing Technology Show in 2024, and SPS—Smart Production Solutions in Atlanta, Georgia, in 2025.

The Automation Sector at IMTS and SPS—Smart Production Solutions in Atlanta will be held in alternate years, and both events will be supported by Gardner Business Media (GBM).

Automation Essential

The Automation Sector at IMTS 2024, powered by SPS—Smart Production Solutions, will feature an expansive offering of automated, robotic, connected, and digital manufacturing technologies. IMTS 2024 runs Sept. 9–14 at McCormick Place in Chicago...

IMTS 2022, the largest manufacturing technology event in North America, witnessed an unprecedented number of demonstrations featuring robots, cobots, vision systems, and other automated solutions around manufacturing processes such as additive manufacturing, CNC machining, metrology, and part handling. Exhibitors featured complete system-solutions that also included connectivity for data management and process optimization, as well as digital twin technology and new solutions for CAD/CAM and ERP/shop management software.

"The Automation Sector at IMTS expands IMTS' appeal as a must-attend event for businesses that want to increase their manufacturing efficiency through automation," says Douglas K. Woods, president of AMT, which owns and produces IMTS. "By working with SPS—Smart Production Solutions, IMTS 2024 will have even more exhibits featuring advanced motion systems, vision and imaging, data analytics, systems integration, artificial intelligence, and cloud and edge computing."

Solutions Tomorrow

SPS—Smart Production Solutions will be held Sept. 23–25, 2025, at the Georgia World Congress Center in Atlanta. The inaugural event will host exhibits from simple sensors to intelligent solutions, from what is feasible today to the vision of a fully digitalized industrial world.

"Manufacturing in the Southeast region is flourishing, and as one of the national leaders in advanced manufacturing, Georgia is the perfect backstory for an automation industry event in the United States," says Constantin von Vieregge, president and CEO, Messe Frankfurt Inc. "Working in concert with AMT, GBM, and our sister company, Mesago, the development of SPS—Smart Production Solutions in Atlanta will cater to a multiplicity of sectors providing a platform to elevate the advancing technological innovations."

The Atlanta event is an expansion of the SPS—Smart Production Solutions trade show held annually in Nuremberg, Germany. It is Europe's leading trade fair for digital industrial solutions. SPS 2022 attracted 44,000 visitors and featured about 1.2 million square feet of gross exhibition space and 1,000 exhibitors involved in advanced automation solutions. As an international meeting place for the industry and representing the complete spectrum of smart and digital automation, SPS—Smart Production Solutions in Atlanta will benefit from the international network already established in Germany.

Together, both events will facilitate a faster exchange of knowledge, which is particularly relevant to global issues involving supply chains, logistics, staff shortages, and cost pressures. All these issues increase the need for automation technologies that leverage worker productivity and boost business profitability. "The SPS in Atlanta in the alternative years allows for the continuity of this ever-important exchange," underlines Martin Roschkowski, president of Mesago Messe Frankfurt. "The strength of SPS in the global automation industry, coupled with IMTS, will provide important business platforms for companies involved in this rapidly changing environment."

Mesago Messe Frankfurt also produces SPS fairs in China, Italy, and the Middle East, as well as events focusing on electronic assemblies, intelligent motion, and additive manufacturing.

"Creating the Automation Sector at IMTS and SPS—Smart Production Solutions in Atlanta reflects our commitment to helping manufacturers enhance and accelerate their productivity and support the expanding US manufacturing market," says Woods. "By working with Mesago Messe Frankfurt, we can showcase an even broader spectrum of digital technologies that are essential for fueling manufacturing growth."

Additionally, Mesago Messe Frankfurt, AMT, and Gardner Business Media recently announced a collaboration to bring several Formnext additive manufacturing events to the United States, including launching Formnext Chicago in 2025.

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April 18–19—Nextlub 2023

Lubricants and tribological systems are undergoing rapid change. The challenges and uncertainties are enormous. Ecological challenges such as the de-carbonization of industry, mobility and society on the one hand, economic challenges such as the resilience of global supply chains on the other, are changing the way lubricants and tribological systems will be developed, validated, produced and applied in the future. Within the Nextlub program (Dusseldorf, Germany) innovative solutions will be addressed to cope with the major challenges of future tribology engineering. The topics span from base materials and chemical compositions over new design, development and validation requirements to new applications and operation boundaries.

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May 4–10—Interpack 2023

Around 2,700 key players and newcomers from all over the world are using Interpack as a stage to present their premières and celebrate the long-awaited reunion of the global packaging industry (Dusseldorf, Germany). Numerous specials, like the lecture program as well as trending topics of the industry add to what is offered for visitors. To help visitors not get lost in 18 trade fair halls, the halls feature a custom concept based on the core target groups food, beverages, confectionery and baked goods, pharmaceutical products, cosmetics, non-food and industrial goods. "Every part counts" is the motto of the Components trade fair, which takes place parallel to Interpack as its own event. This is where you find companies offering technology for drives, control units and sensors, products for industrial imaging, handling technology, industrial software and communication as well as comprehensive automation systems for the packaging industry. There are also machine parts, components and equipment, peripheral devices as well as components and aids for packaging.

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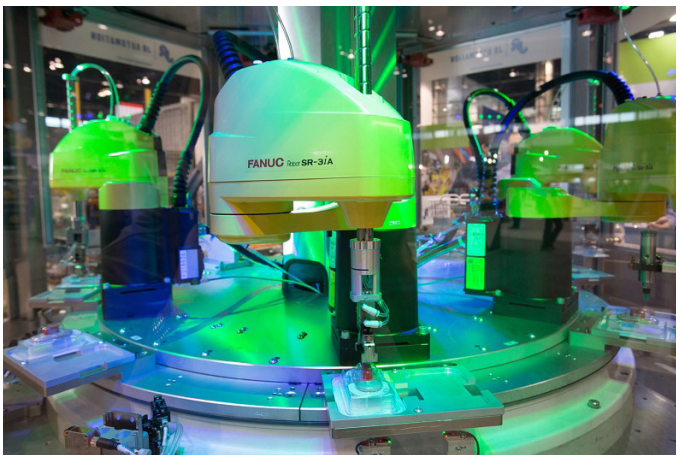
May 22–25—Automate 2023

Between intimate workshops, news making keynotes, networking events, innovation competitions and live demonstrations, Automate offers comprehensive automation education and cutting edge robotics, vision, AI, motion control and other technologies. Automate (Detroit) delivers the latest innovations in manufacturing automation technology from more than 600 leading exhibitors. Each day also offers inspirational keynote sessions and theater presentations to help attendees find the best solutions for their unique business needs. In addition to seeing demos of the latest automation solutions, Automate show attendees can watch keynote sessions highlighting how these technologies solve real-world challenges or participate in small group discussions in the theater sessions covering important topics.



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May 24–25—CTI Symposium USA 2023

The CTI Symposium USA (Novi, Mich.) will update attendees on the latest technical developments and applications on automotive transmissions for conventional and alternative drives. Exchange experiences, discuss technologies and strategies with automotive experts from the United States, Asia and Europe. The conference and exhibition provide expert-led plenary and technology sessions as well as expert discussions and product showcases representing the full range from complete drivetrain systems to components and engineering services. CTI drives progress in passenger cars and commercial automotive transportation. Manufacturers and suppliers are actively demonstrating how to keep pace and staying ahead of customer needs, environmental, institutional and economic demands.

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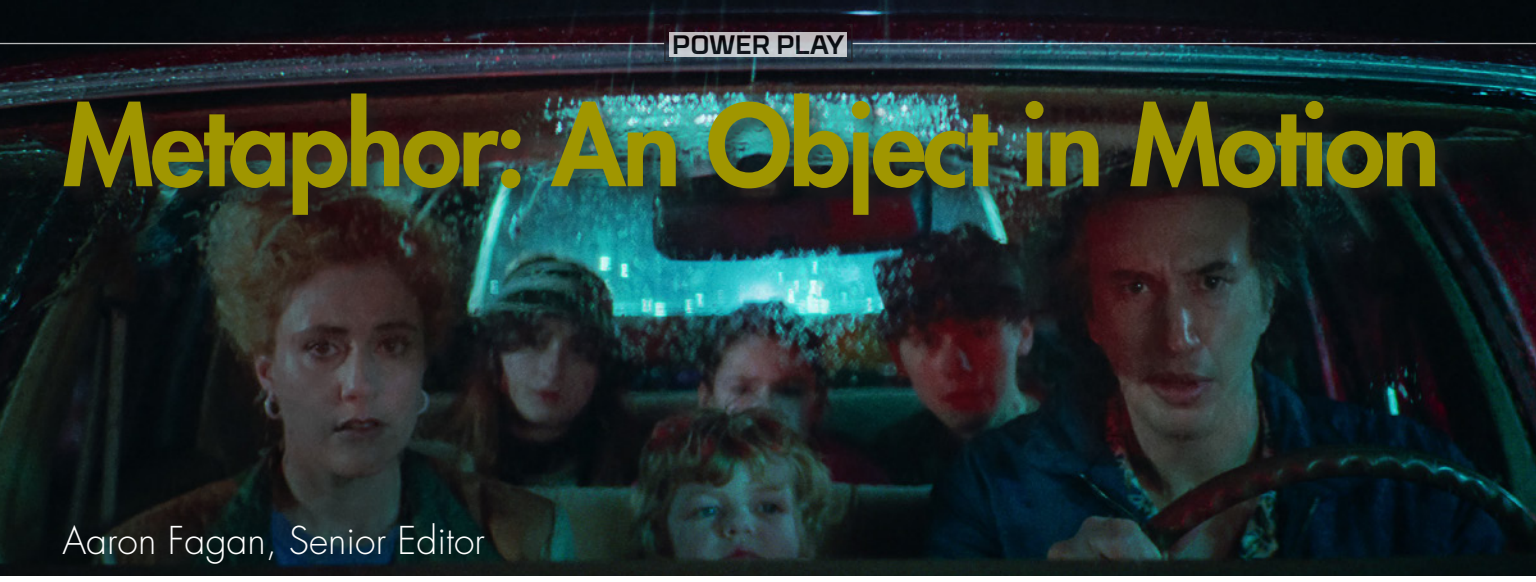
Metaphor: An Object in Motion



Aaron Fagan, Senior Editor

A still from Noah Baumbach's adaptation of Don DeLillo's novel* White Noise. *(Netflix)

Streaming now on Netflix is director Noah Baumbach's adaptation of author Don DeLillo's 1985 classic *White Noise*, a postmodern campus novel about the dangerous influence of the careless use of scientific inventions and technology which won the National Book Award the year it was published.

White Noise opens with a college lecture from Professor Murray Siskind (Don Cheadle), addressing both his students and the viewer: "Roll film," he begins as the movie roars to life with a montage of car crashes drawn from the history of American filmmaking—the whole of cinematography is reduced to its essential conceit: an object in motion.

The etymology of *cinema* is from the ancient Greek κίνημα (kínēma) meaning "movement," and a movie is a fiction using metaphor, which, incidentally, is also from the Greek for μεταφορά (metaforá) meaning "to transport." Prof. Siskind isn't simply interested in motion; he's obsessed with collision yet careful not to frame the scenes in morbid or macabre terms. "Don't think of a car crash in a movie as a violent act," he urges his students. "No, these collisions are part of a long tradition of American optimism," the professor argues. "Each crash is meant to be better than the last," he explains. "There's a constant upgrading of tools, skills, a meeting of challenges."

At the heart of the film, a massive train accident leads to what is termed an "airborne toxic event" resulting in the evacuation of a neighboring town. Truth is still stranger than fiction and at times fiction collides with reality: On February 3rd, the actual neighboring town, East Palestine, Ohio—where *White Noise* was filmed and many of the locals were hired as extras—was evacuated after 20 train cars carrying hazardous materials derailed.

What the incident calls attention to in the real world is a society where the "constant upgrading of tools, skills, a meeting of challenges" Prof. Siskind celebrated are being exercised to create transportation that is designed to avoid or minimize the impact of a collision. This can be achieved through various technologies such as advanced driver assistance systems (ADAS), autonomous driving capabilities, and smarter vehicle design.

Some manufacturers are already incorporating these technologies into their vehicles, and different types of ADAS are already in operation in railways in many countries around the world, such as automatic train protection, collision avoidance, and automatic train operation systems. ADAS is used for condition monitoring track and rolling stock providing real-time information to train drivers and control centers. With the increasing dependence on ADAS technology, the importance of cybersecurity will become more critical. Future ADAS systems will need to be designed with robust security measures to prevent hacking and other malicious attacks.

ADAS is expected to play a crucial role in the development of autonomous vehicles, with the goal of eventually reaching full automation. The continued development of sensors and data processing algorithms will enable ADAS technologies to provide more accurate and reliable information about the vehicle's environment with the potential of advancing the safety, performance, and efficiency of transportation.

White Noise presents a satirical view of the overreliance on technology and the illusion of safety that it can create. It highlights the ways in which people can become so dependent on technology that they lose touch with reality and become vulnerable to unexpected events. ADAS in railways can be seen as an example of how technology can be used to enhance safety and efficiency, but also as a potential source of complacency and a loss of agency for human operators. In this way, the use of ADAS in transportation could be interpreted as a contemporary manifestation of the same underlying themes that DeLillo critiqued in *White Noise* when he wrote:

"The car seemed to have no sense of being alive, no sense of its own reality. It was pure function. The tires contacted the road, the motor pressed us forward, the brakes stopped us, the steering mechanism directed us. All of it was robotic, inhuman. There was no sense of being part of a living thing, of participating in the flow of the universe. It was as if we had removed ourselves from the natural order of things, from the cycles of birth and death and regeneration, and entered into a world of pure technology, a world of perfect efficiency and control.... The road ahead of us seemed infinite, like a tunnel with no end. Anything could happen."

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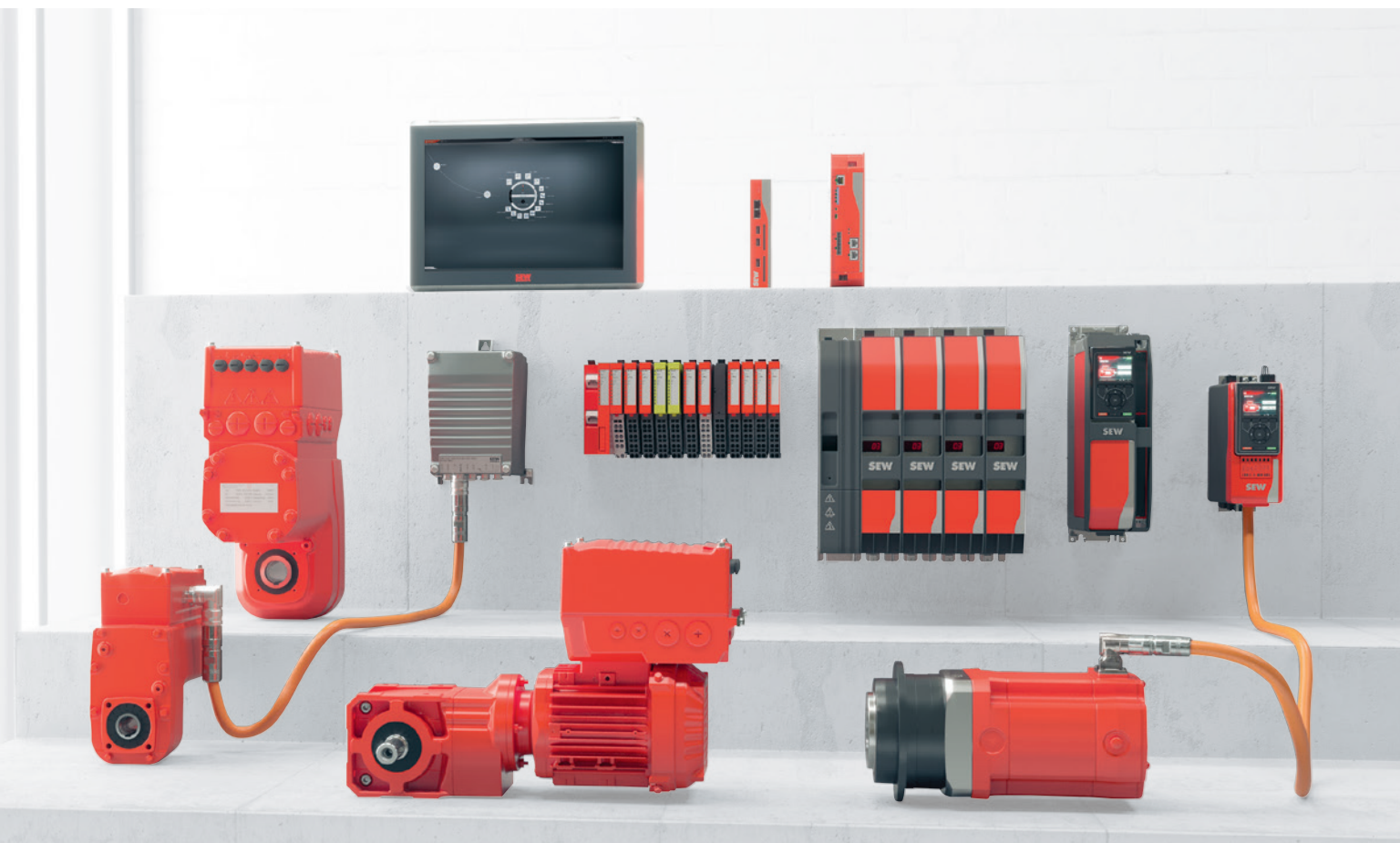

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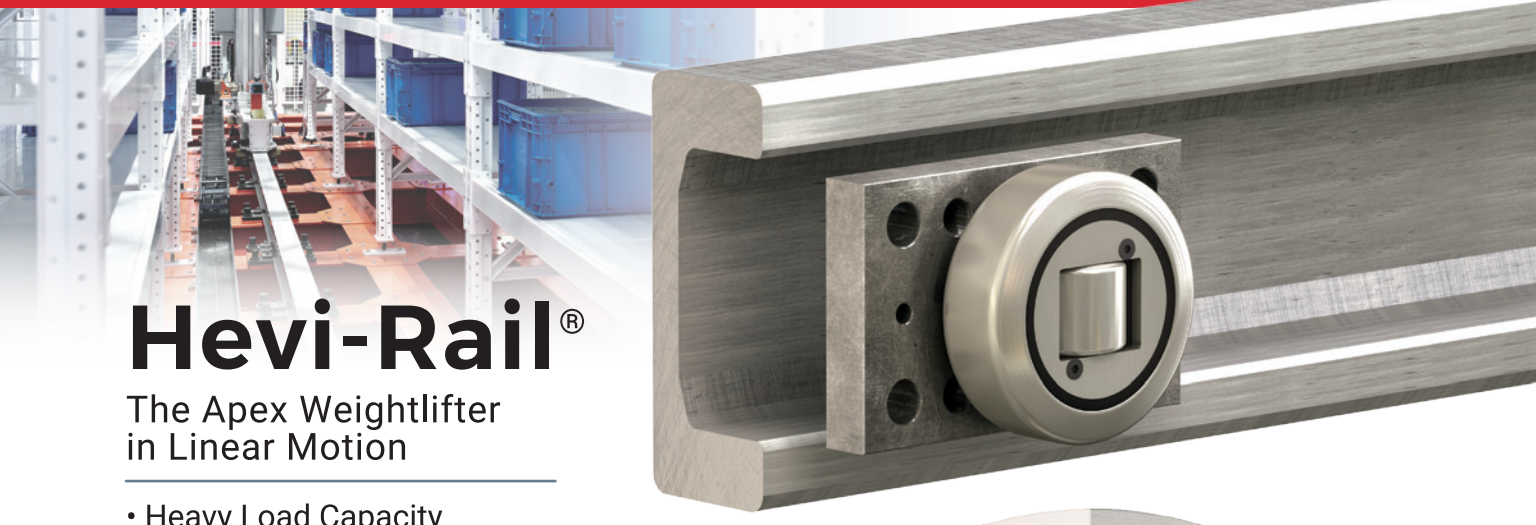

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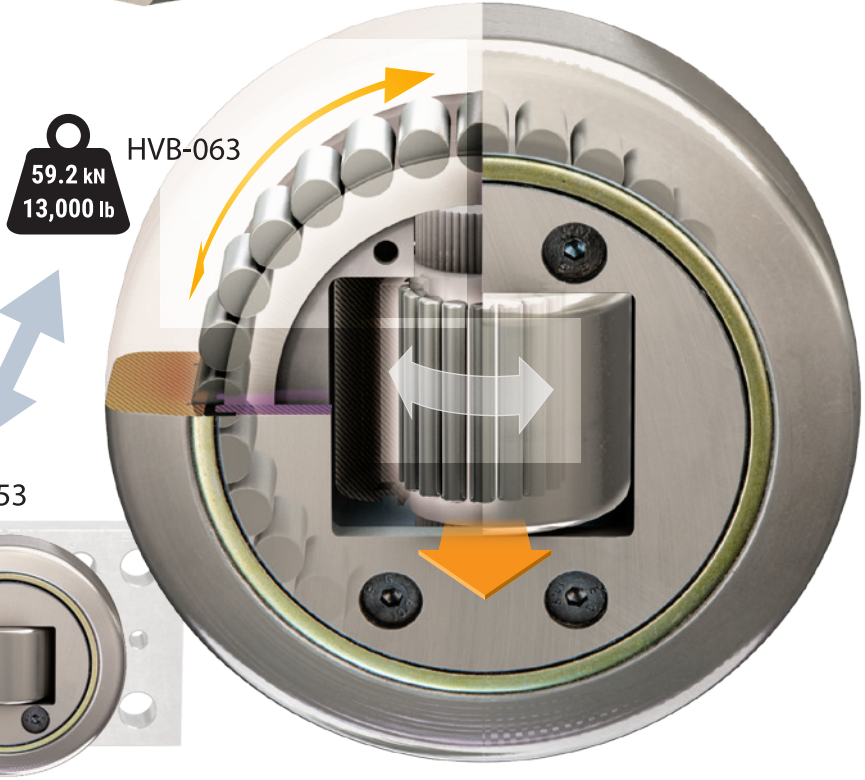

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