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DECEMBER 2021

MOTION CONTROL

LINEAR MOTION

ANNUAL BUYER'S GUIDE

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RYAN MILLER,
Owner and Engineer Manager
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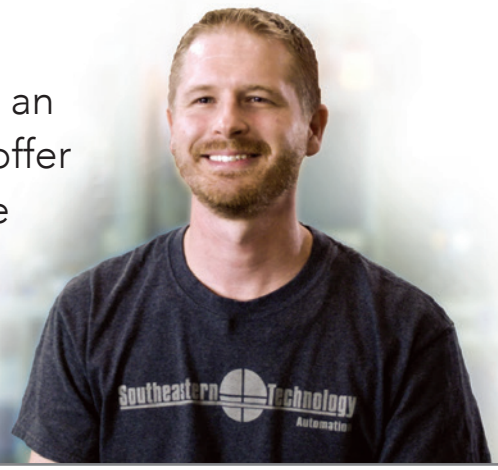

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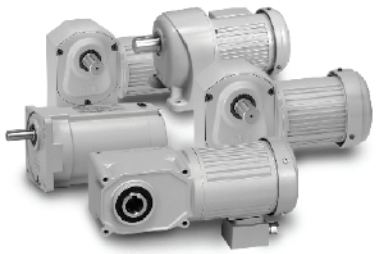

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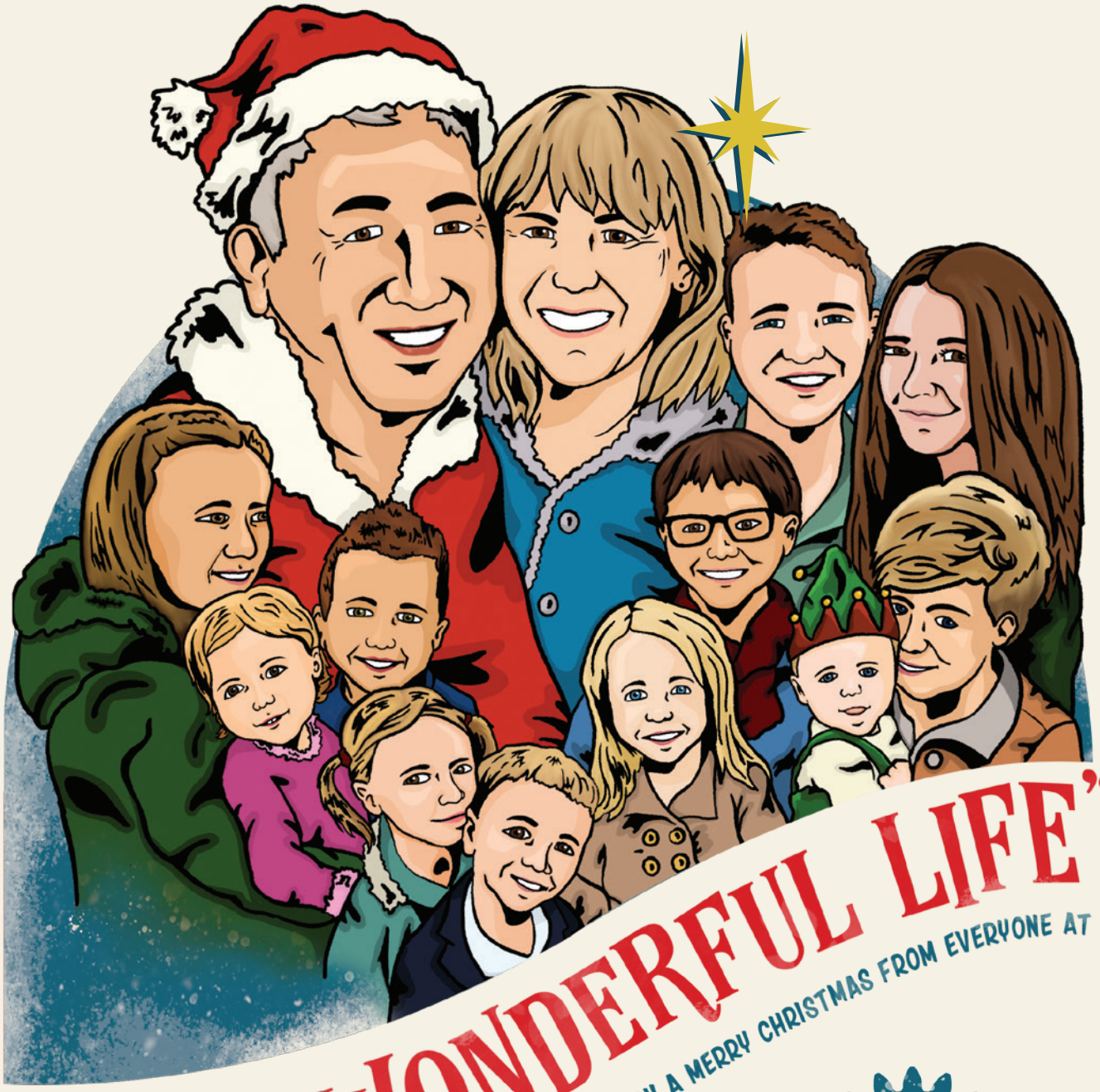
FRED YOUNG

WENDY YOUNG



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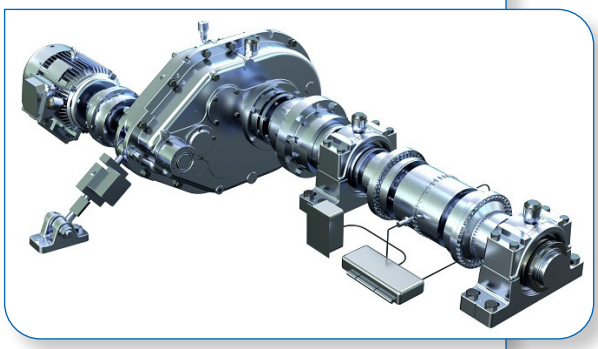
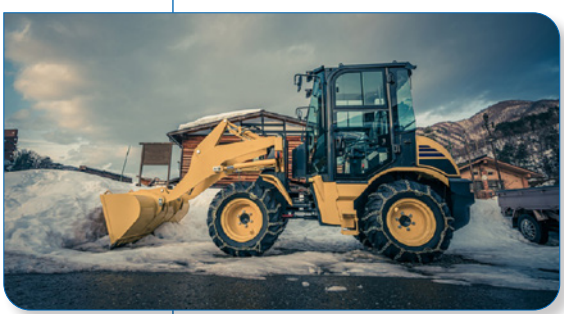
Regal Rexnord Enhances Industrial Powertrain Capabilities



The Regal electromechanical powertrain offering encompasses a broad range of Regal-produced components (e.g., motors, speed reducers, gearing, couplings, bearings, belt drives and more) that can be integrated to create complete end-to-end solutions, customized to meet specific application requirements, and optimized to maximize energy efficiency and productivity. ***Power Transmission Engineering*** recently caught up with Chris Carrigan, vice president of engineering at Regal Rexnord and Joe Bierschbach, engineering manager—gearing at Regal Rexnord, to discuss the organization's latest powertrain capabilities. Learn more here:

www.powertransmission.com/blog/regal-rexnord-enhances-industrial-powertrain-capabilities/

Global Hydraulic Fluid Market with Lubrizol



The size of the worldwide hydraulic fluids market is expected to be worth $77.5 billion by the end of 2021 and this growth is expected to continue year on year through 2024. That's why smart lubricant manufacturers see it as one of the most lucrative opportunities at their disposal. To capitalize on this opportunity, however, it's important to understand the current state of play of the hydraulic fluids market, as well as the trends and challenges that face the market moving forward. Learn more here:

www.powertransmission.com/blog/?p=1426&preview_id=1426&preview_nonce=fe1218bb6e&_thumbnail_id=1427&preview=true

Event Spotlight: SciTech 2022

The American Institute of Aeronautics and Astronautics (AIAA) conference provides scientists, engineers, and technologists the opportunity to present and disseminate their work in structured technical paper and poster sessions, learn about new technologies and advances from other presenters, further their professional development, and expand their professional networks.

www.aiaa.org

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Randy Stott
Publisher & Editor-in-Chief

I know a Guy

We all have a friend, relative or acquaintance who always seems to have the right connection, no matter what you need. Car broke down? "I know a guy." Need to get a traffic ticket fixed? "I know a guy." Need a plumber, some investment advice or tips on buying a new phone? "I know a guy."

Well, when it comes to mechanical power transmission components, we ARE that guy.

This issue we present our annual printed Buyer's Guide, your handy resource for finding the manufacturers and suppliers of the mechanical power transmission and motion control components you need.

A Buyer's Guide seems like such an antiquated thing, right? I mean, after all, you can just go to Google and type in what you're looking for and be directed to plenty of willing and able suppliers. Easy-peasy.

Well, not so fast.

It's hard to know who you can trust out there, and the need for reliable, accurate, up-to-date information about suppliers and their capabilities is as important as ever. Just over the past week, I've had three different people come to me personally looking for recommendations about gear manufacturers who can handle this or that project.

They came to me because I've been in the industry for 27 years. I know people. I talk to manufacturers. Rather than sift through pages and pages of search engine results, they go to their guy. They know I can get them very quickly to the handful of suppliers who might best be able to help them.

Of course, invariably, before I do anything else, I point them toward our Buyer's Guide. And although the one you have in your hands is incredibly useful as a starting point, there's a lot more detail in the online guide. At *www.powertransmission.com*, you get full contact information, descriptions of the companies' capabilities and breakdowns of the broad product and service categories into specific part and component types.

People come to me — and to the Buyer's Guide of *Power Transmission Engineering* — because we're trusted resources. That trusted friend you go to for advice has personal experience, and his referral is way better than choosing randomly. We're like that, too. Unlike the millions of responses you typically get from a Google search, our Buyer's Guide narrows it down to the results that matter. Also, our directory is vetted by our editors — people like me with decades of experience in the industry. We save you time by making sure the listings are accurate.

And it's about to get even better.

Beginning in 2022, you're going to see some really great improvements to the online Buyer's Guide, including the addition of even more details on each company. Those listed in the Buyer's Guide are going to have the opportunity to add videos, product literature and more. There will be tight integration between the directory and the rest of the content on our site. You'll be able to quickly and easily learn more about each company by reading the articles they've written or been featured in, watching the videos they've posted or been a part of, and learning about the products, services and company news related to their company.

We've been working hard on these improvements for almost a year, and they're just about ready to go. Stay tuned to this page for more details over the next couple of issues.

In the meantime, please take full advantage of both this printed guide and the online guide at *powertransmission.com*.

P.S. If your company manufactures gears, gear drives, bearings, motors, couplings or any other power transmission or motion control component, NOW is the time to get listed (for FREE!) in the online directory. Just go to *www.powertransmission.com/getlisted.php* to make sure you're first in line to take advantage of our improvements as they roll out in the beginning of 2022.

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SKF

EXTENDS RANGE OF LARGE BEARINGS FOR ROLLER PRESSES

SKF has extended its range of large bearings for roller presses, with a sealed version that prolongs service life.

Its Explorer spherical roller bearings (SRBs) in the 241 series are now available up to 1,250 mm bore. This series and sizes are commonly used in high-pressure grinding rolls (HPGRs) in cement and mining industries.

"Using sealed bearings is the best way to increase mean time between failures," says Daniel Ortega, product line manager for Sealed SRBs at SKF. "It is a long-term investment that increases machine availability and reliability.

The new version — which is sealed on both sides — offers up to double the lifetime of an open bearing and have showed in tests that it reduces grease consumption up to 99 percent. In a high-pressure grinding roll, four large spherical roller bearings are usually used. During a maintenance interval of three months, normally 540 kg of grease is used for certain sizes. With SKF sealed Explorer spherical roller bearings, only seven kg of grease is needed during the same interval which reduce both cost and environmental impact.

In addition, the sealed SRB can be remanufactured twice, which further extends service life. This raises productivity and machine availability while lowering total cost of ownership.

The new bearing has been redesigned to have a higher load-carrying capacity. Bearings with a bore-diameter below 1,000 mm have an HNBR seal that is retained by a snap ring. Larger bearings use a G-ECOPUR seal that is bolted to the bearing's outer ring.

The sealed bearing can be used on its own, or as part of an SKF three-barrier solution. Typical end-use applications include the mining, mineral processing and cement industries

Roller press bearings often wear out because ineffective sealing leads to lubricant contamination. The sealed bearings overcome this problem — and this delivers several advantages:

Firstly, bearing failure relates to more maintenance interventions — which carries a higher risk of accident and injury and expensive shutdowns.

The new design also offers a maintenance benefit. Rather than stopping production for preventive maintenance of the bearing, the wear of the roller press roller determines when a service is needed.

The bearings are available with short delivery times — even in the largest sizes.

www.skf.com


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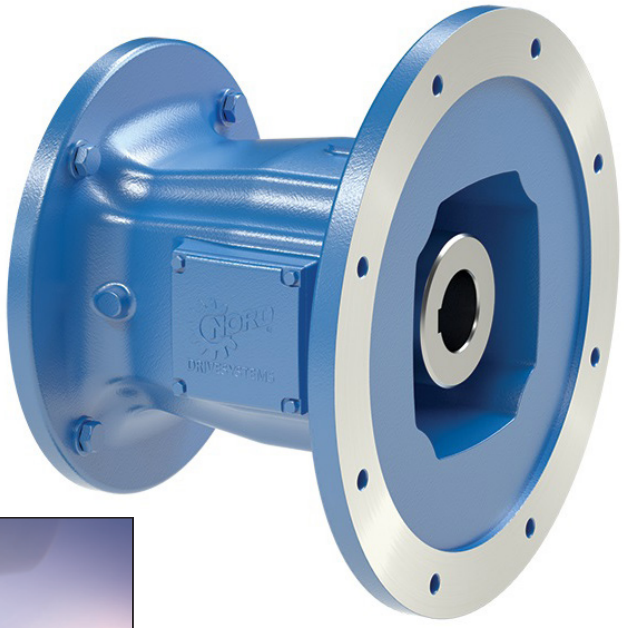
NORD

INPUT ADAPTERS ENHANCE PERFORMANCE AND FLEXIBILITY IN DRIVE SYSTEMS



NORD's newly improved NEMA and IEC input adapters offer improved mechanical and thermal performance, giving users more flexibility in designing drive systems and allowing for a broader range of application and environment-specific concepts through extended options such as integrated backstops and speed sensors. The redesigned input adapters are available NEMA sizes 250TC–400TC and from IEC sizes 160–315.

These innovative NEMA/IEC input adapters showcase improved technical capabilities — 3600 rpm max input speed, increased bearing life, and serviceability. They also come equipped with FKM seals as a standard and bearings that will last for a minimum of 25,000 hours, resulting in trouble-free operation for longer periods before requiring maintenance.

NORD's redesigned NEMA and IEC adapters are made of cast-iron and consist of a single casting that eliminates the need for adapter plates. This manufacturing process reduces the total number of parts that need to be stocked, resulting in a lower sell price and providing better overall value. The improved housing also results in a significant reduction in heat generation, nearly -20 K less temperature rise compared to the legacy version. The adapters come standard with a fail-safe ROTEX coupling and are designed for easy integration of backstops and speed sensors to meet application needs. To support commissioning and service, an inspection cover was added for quick feedback on engagement and spider condition. Permalubricators and grease drain cups will no longer be needed as the new adapters come prepared with lifetime grease as well as provisions for re-greasing if necessary, adding to the low maintenance advantages these NEMA and IEC adapters provide.

www.nord.com

IKO

INTRODUCES NEW CROSSED ROLLER BEARING

IKO International has unveiled its newest crossed roller bearing — the CRBT105A. This ultra-small, ultra-thin unit is designed to provide exceptional rigidity for space-constrained automated machine designs.

The CRBT105A features a 10 millimeter bore diameter, 21 millimeter outside diameter and a narrow width of 5 millimeters. Despite its compact size, the CRBT105A offers rigidity up to four times greater than doublerow angular contact ball-type bearings. This combination of small size and high rigidity makes the CRBT105A suitable for robots with articulating arms as well as compact surveillance cameras.

With rollers alternately crossed at right angles to each other between inner and outer rings, the CRBT105A produces a greater contact surface to allow the bearing to handle heavy or complex loads from any direction simultaneously. This orthogonal roller arrangement results in a bearing that occupies just half the sectional area of rear-mounted, 45-degree contact angle single-row roller or ball-type bearings.

The CRBT105A also features:

- Separators between cylindrical rollers to provide smooth rotation.
- Dynamic load rating of 1,120N and static load rating of 811N.
- Small coefficient of friction for high-speed rotation.
- Lightweight design.

Crossed Roller Bearings are advanced products that are ideal for space-constrained automated machine designs. In addition to the ultra-small, ultra-thin CRBT105A, IKO also offers a wide range of rigid, compact crossed roller bearings that are well-suited for machine tools, industrial robots, medical equipment, and other precision applications.

www.ikont.com

ETEL

OFFERS SHORT STROKE ACTUATORS FOR SEMICONDUCTOR MANUFACTURING

ETEL introduces two new short stroke actuators specifically for use as a unique solution for "Test and Scan" turret handlers in semiconductor manufacturing. Available in North America through parent company Heidenhain, the TUCANA ST and the AQUARIUS ST are an extension of its Z line of actuators, providing users a higher control of force repeatability and better throughput during back-end semiconductor processing, thus reducing the final cost of machine ownership.

In the back-end semiconductor applications, short move and settle times as well as smooth force limitation at low force levels are key parameters that can now be fulfilled with less compromise using these new actuators. The TUCANA ST and AQUARIUS ST have been mechanically optimized with fully symmetrical and balanced design to guarantee long-term friction behavior along with avoiding unwanted move and settle variations. Both these actuators can then cope with smaller nominal forces down to 0.5 N, improve force accuracy, drastically drop the force overshoot and increase the acceleration.

The semiconductor manufacturing processes that could commonly benefit from these new ETEL ST actuators are back-end "Final Test" turret handler applications which include device handling processes which pick up, transfer, test, inspect, mark and/or place key components.

Key specifications of the TUCANA ST and AQUARIUS ST include a total stroke of up to 10 mm, speeds up to 1 m/s, acceleration up to 40 G, and a move & settle time of 2.8 mm within ±10 µm in 6.7 ms. The TUCANA ST has a peak force of 68.4 N along with a continuous force of 12.1 N. The AQUARIUS ST has a peak force of 214 N, along with a continuous force of 31.4 N.

www.heidenhain.us

PBC Linear

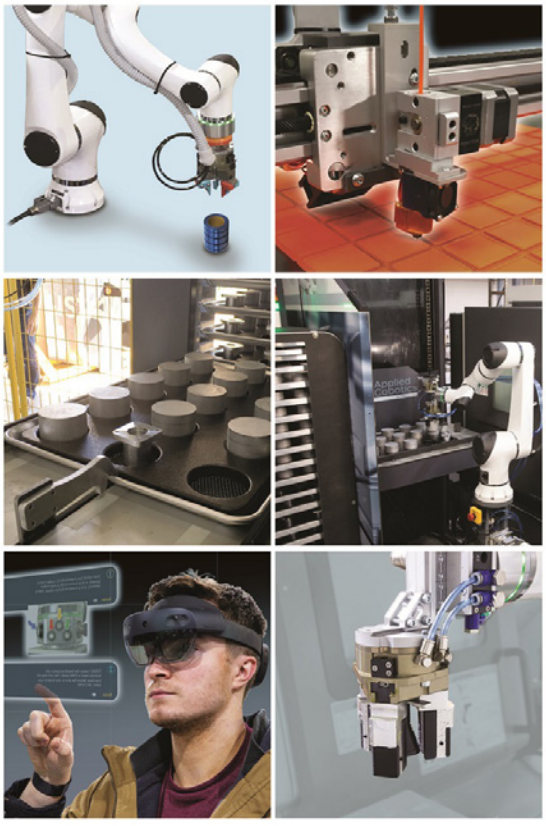
EXPANDS FACTORY OF THE FUTURE PROGRAM WITH APPLIED COBOTICS

PBC Linear continues to elevate their Factory of the Future Program with their newest venture, Applied Cobotics. Its mission aims to provide automation solutions by integrating collaborative robots (cobots), material lift systems, 3D printing, and other automation technologies into manufacturing systems.

Recent events have helped bring to light the unmet demand for skilled workers within the manufacturing industry. This labor shortage is coinciding with a rise in customer demand, creating a need for higher output with more competitive costs. In addition, shop floors are having to evolve on a dime, becoming more agile to fulfill custom orders and mitigate product fluctuations.

PBC Linear has developed its Factory of the Future Program in response to those needs. A significant focus of that program is Applied Cobotics, which looks to implement new and more efficient technologies to accommodate these new demands. This is being accomplished through relevant industry partnerships and home-made innovation that has been a hallmark of PBC Linear for decades.

www.pbclinear.com



Gates

INTRODUCES NEW HYDRAULIC HOSE SOLUTION

Gates has introduced its latest hydraulic hose, MegaSysTM MXGTM 5K, which is lighter, more flexible and more durable than a typical 5000 psi (350 bar) hydraulic hose.

The MXG 5K offers wire spiral performance in a flexible, lightweight, innovative, high-pressure hydraulic hose using Gates patented Xpiral woven spiral technology. MXG 5K was tested extensively in the laboratory and in real-world applications throughout its development, including rigorous field testing in tunnel boring, top drives, excavator and wheel loader applications.

"Our ongoing commitment to research and development has resulted in another world-first innovation from Gates. MXG 5K sets a new standard for hydraulic hose," said Mike Haen, vice president, industrial global product line management. "Combining industry-leading impulse cycle performance at these hydraulic pressures, with the XtraTuff Plus (XTP) cover and the weight and flexibility advantages, delivers a hydraulic solution for the most demanding applications. Nothing else on the market matches MXG 5K."

MXG 5K is a design-in option or replacement hose solution across a wide variety of industries, including injection molding, heavy manufacturing equipment, mining, forestry, construction, agriculture and logistics, among others. Tested to one million impulse cycles at 250 degrees Fahrenheit (121 degrees Celsius), twice the legacy industry standard for spiral hoses, and with a bend radius that is also 50% of the industry standard, MXG 5K offers truly unparalleled performance.

In addition, this new hose platform is 20% lighter, 25% more flexible and 5% more compact than legacy spiral hoses, improving the safety and ergonomics of hose installation while also enhancing the performance of machinery by reducing weight. Equipped with Gates' XTP cover as a standard offering, MXG 5K also offers 25 times the abrasion resistance of Gates' standard cover and more than 800 hours of ozone resistance to minimize downtime related to environmental conditions. As a result, MXG 5K will last longer in the factory or field, including applications in the most extreme conditions.

www.gates.com/mxt

SDP/SI

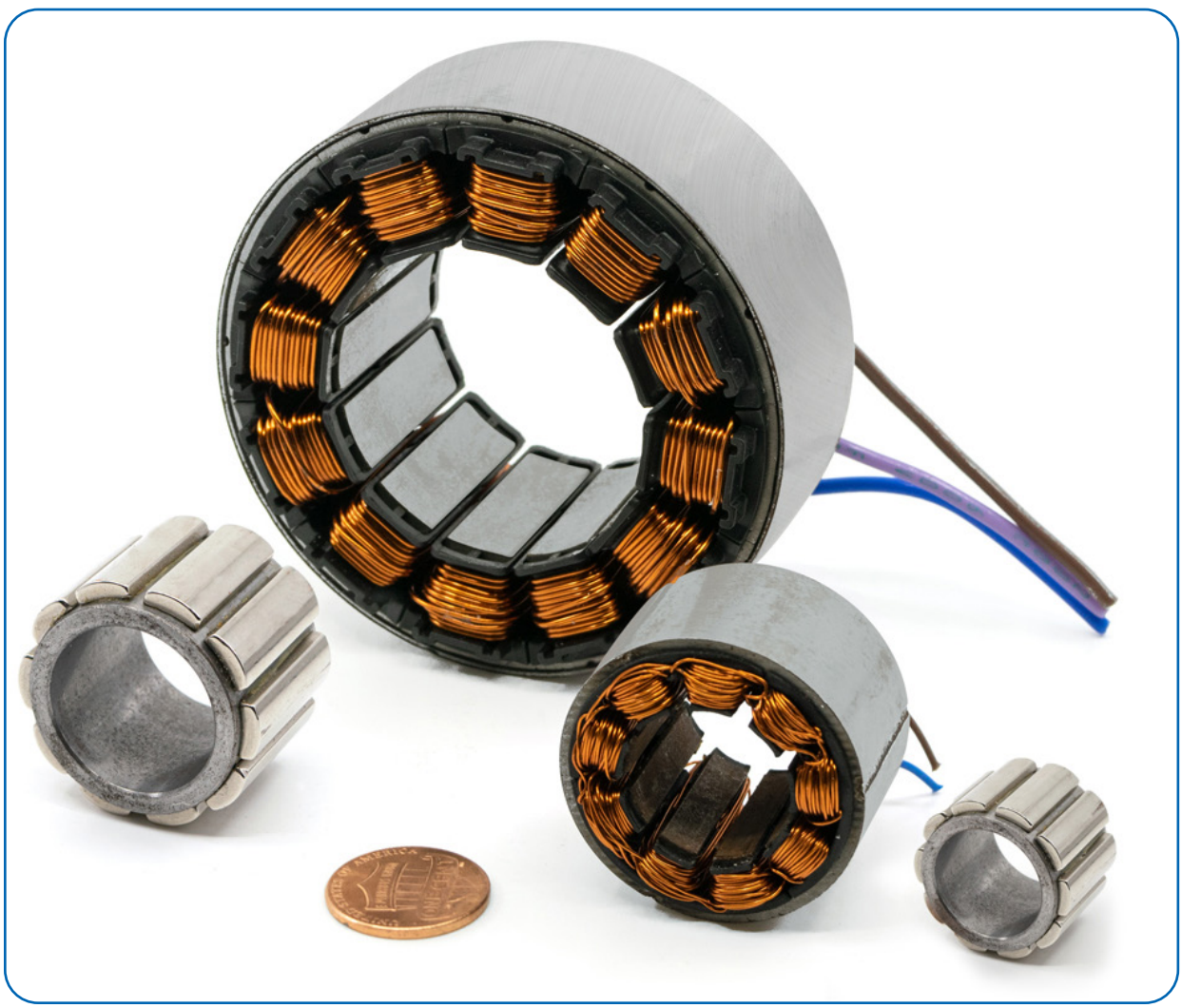
OFFERS BRUSHLESS MOTORS FOR ROBOTIC APPLICATIONS

Rapid growth in the industrial automation market is producing an urgent need for premium quality parts and services. Stock Drive Products/Sterling Instrument (SDP/SI), a leader in providing mechanical and electromechanical based design, engineering, and precision manufacturing for critical motion and power transmission applications is launching a series of Frameless Motors as a drop-in solution for robotics applications.

Designed to be pressed into a machine's housing, the SDP/SI NH1-D series Frameless Brushless Motors provide a compact, lightweight, and powerful motor solution. Available in standard sizes, 35 mm, 52 mm, 64 mm, 77 mm, and 100 mm, the frameless motors are machine wound with bondable magnet wire for superior dependability. Each motor features a large inner diameter rotor permitting easy cable management.

With their compact size the NH1-D series frameless motors fit easily into smaller machines requiring precision, high efficiency, low inertia, and high torque density. "Rated for continuous operation the frameless brushless DC motors are an ideal solution for many applications including the replacement of heavier, traditional motors by eliminating components, reducing torsional losses, decreasing weight, system inertia, and size envelope, while providing maximum speed control," said Jacques Lemire, business unit director, Motors & Motion Control. "Offering an assortment of motion control solutions that ensure accuracy and dependability the frameless motors provide an additional option to those in the robotics, industrial automation, and medical industries."

Sdp-si.com



Siemens Digital

RELEASES 2022 VERSION OF SOLID EDGE SOFTWARE

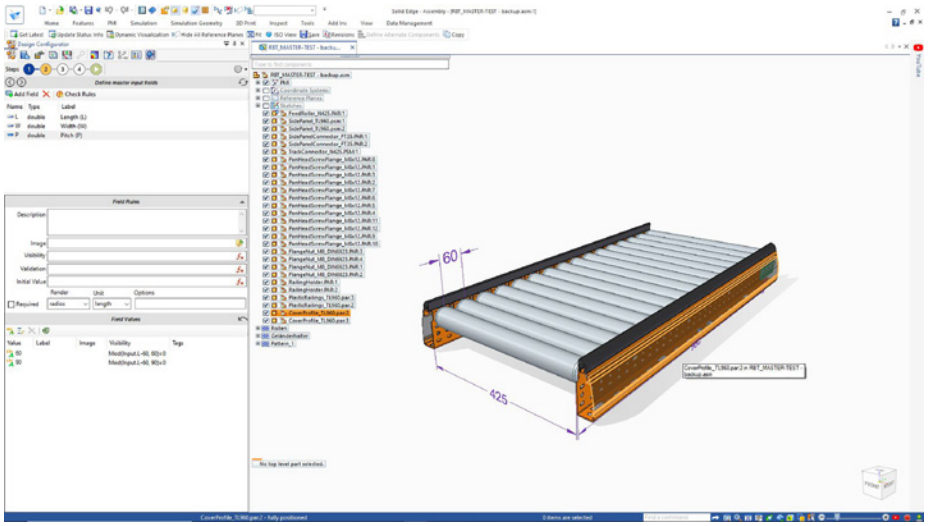
Siemens Digital Industries Software has released the 2022 version of Solid Edge software, which brings embedded rules-based design automation, greater capabilities to work with point-cloud, mesh and imported data without the need for translation alongside new tools to for 2.5 axis machining and ultra-efficient upfront fluid flow simulation. Part of Siemens' Xcelerator portfolio of products, Solid Edge is an intuitive product development platform for accelerating all aspects of product creation, including 3D design, simulation, visualization, manufacturing, and design management.

Highlights for Solid Edge 2022 include:

The new embedded Solid Edge Design Configurator adds rule-based automation and enables quick customization of products based on design parameters and rules, saving time and enabling the capture and reuse of intellectual property in intelligent models.

CAM Pro 2.5 Axis milling is now included in Solid Edge Classic, Foundation and Premium for customers with active maintenance. Fully integrated, it maintains full associativity with design data and provides automated tool path creation combined with machining simulation to help achieve optimized machining operations.

New CAD Direct capabilities allow insertion of third-party data formats



without the need for translation while maintaining associativity. Solid Edge 2022 continues to integrate Siemens' leading Convergent modeling technology, allowing users to mix b-rep and mesh geometries in the same model, again without conversion, making mesh data more useful and reducing product modelling time. Full-color point cloud data can also now be used for visualization purposes directly within Solid Edge, especially useful when retrofitting factories or plants, allowing the positioning of design equipment in the context of the point clouds.

Solid Edge 2022 is available through Xcelerator as a Service, providing access to Siemens' next-generation, cloud-based collaboration solution including Xcelerator Share, that brings design-focused capabilities (such as 3D/2D CAD view/markup), augmented reality and secure project-based sharing to the Solid Edge community.

"We have been working with and listening to our customers, and in response Solid Edge 2022 has been engineered to help them grow their businesses," said John Miller, senior vice president, mainstream engineering, Siemens. "The enhancements to Solid Edge 2022 better support modern product development and manufacturing processes, allowing our community of users to do more with available resources and to enable new ways of working that will foster greater innovation."

Assembly modelling is a constant focus and the 2022 release of Solid Edge delivers the third straight release of improvement. The new Assembly preview mode reduces the amount of data that is loaded, while multi-body assembly modeling mode is a new environment to model internal components within an assembly file. When it comes to locating those hard-to-find parts, the new component finder puts intuitive search at the fingertips with auto-complete suggestive filters.

Finally, Solid Edge 2022 introduces Simcenter Flomaster for Solid Edge software, which brings easy analysis of fluid and thermal flows in piping systems. System-level models are extracted from 3D models (reducing preparation time by up to 90 percent). Built in wizards guide new users towards successful results, while retaining advanced capabilities, such as simulation of rapid dynamic events and pressure surge, for experienced users.

solidedge.siemens.com/en/

Motion Control Trending Topics 2021

Matthew Jaster, Senior Editor

Digital transformation is taking place across industrial manufacturing and is most prominent in areas such as motion control, automation and robotics. How will today's technologies transform the factory of the future? More importantly, what areas does your organization need to focus on in 2022 as we start a new chapter of productivity post-COVID in a world with less skilled workers, more automation and an ever-growing list of new and challenging obstacles? We asked what the future has in store for automation and motion control and you answered.

Wittenstein is the first component manufacturer to offer smart gearboxes as standard and has partnered with Bosch Rexroth to help customers integrate their products into an accessible system solution.

Digital Ecosystem Gains Traction

Bosch Rexroth has been highlighting its ctrlX AUTOMATION platform for months and we're starting to see real-world case studies in the power transmission and motion control markets.

More than 300 companies are currently implementing the solution in their applications and the step from an open platform to an industrial ecosystem has now been taken with the launch of ctrlX World in 2021. Significant enhancements to the solution were also made this year — and further enhancements are planned.

"Industrial automation is increasingly dominated by software. We therefore need automation solutions which are geared to increasingly digitalized industry. Among other things, they should support various programming languages, offer data communication systems and allow IT and OT to be connected in a straightforward but secure manner. Today, we know that ctrlX AUTOMATION meets the automation challenges not only in mechanical engineering but also in numerous other areas such as energy, mobility and building automation," said Steffen Winkler, CSO of the Automation & Electrification Solutions Business Unit at Bosch Rexroth.

Bosch Rexroth makes it easy to create, provide and use functions with ctrlX WORKS where users enjoy maximum flexibility thanks to a full range of software and programming tools. Known as the software and engineering toolbox, ctrlX WORKS includes an extensive portfolio of high-performance libraries and building blocks for typical automation tasks. In addition, users can develop their own applications in any programming language.

In 2021, a wide range of new functions for even more efficient engineering processes were added. For example, ctrlX CORE can now handle Docker images too. With the Software Development Kit (SDK), which is available to all developers on GitHub, users can now develop their own apps even more easily. A development environment for Python and Google Blockly which is integrated into ctrlX CORE is another highlight. As a result, users can now carry out development directly on the ctrlX CORE hardware. When it comes to automating engineering processes, ctrlX WORKS now offers a simple, clearly structured script interface, the Automation Interface. Recurrent engineering processes can be automated using simple scripts. This reduces the work involved by 80-90%.

Wittenstein Offers Apps for Smart Gearbox

Wittenstein is part of the ctrlX World — the partner world around the ctrlX AUTOMATION system from Bosch Rexroth. This allows users to benefit from the advantages of Wittenstein's smart cynapse gearbox via the ecosystem. ctrlX AUTOMATION supports the openness of cynapse and enables easy integration of corresponding applications. Customers can thus integrate smart services from Wittenstein into their system solution quickly and in a user-friendly manner.

"The development of smart machine concepts by machine builders, but also the increasing digitalization of existing machines by operators, should bring cost advantages and increase competitiveness. Companies want to continue to increase their process stability,

minimize waste and make the entire manufacturing process efficient and sustainable. This is precisely the kind of application for which we developed the smart cynapse gearbox," explains Patrick Hantschel, director of the digitalization center at Wittenstein.

Wittenstein is the first component manufacturer to offer smart gearboxes as standard — gearboxes with cynapse. They have an integrated sensor module that enables Industry 4.0 connectivity. This solution can also be combined with smart services. Among other things, these software applications enable the combined analysis of machine and sensor data, which detects possible failures much earlier than is the case with conventional condition monitoring solutions.

"The ctrlX AUTOMATION platform leverages the openness of cynapse and supports the easy integration of overarching applications. This means users can easily integrate smart services from Wittenstein into their system solution. This enables the quick and easy implementation of condition monitoring, process monitoring and drive train control," says Hans Michael Krause, head of product management ctrlX World at Bosch Rexroth AG.

This synergy between Bosch Rexroth and Wittenstein is realized through the ecosystem around the ctrlX AUTOMATION platform. Via the open automation platform and its ctrlX World for partners, desired functions can be easily downloaded in the form of apps. Here, users can employ apps from Bosch Rexroth, third-party apps or apps they have created themselves. ctrlX AUTOMATION provides all the components for complete automation solutions. The platform offers an open software architecture, a complete hardware portfolio as well as IoT, security and safety functions. This means that the system can be expanded at any time to include applications as well as hardware and software from third-party suppliers.

"Due to the maximum openness of ctrlX AUTOMATION, which is also reflected in the ctrlX World, our customers and we benefit from an easy integration of overlapping applications and a constantly growing ecosystem. This also enables us to achieve a high reach for our solutions," added Hantschel.

www.boschrexroth.com/ctrlxautomation

The step from an open platform to an industrial ecosystem has now been taken with the launch of ctrlX World in 2021.

Cloud-Based Production Technology Maximizes Assets

Cloud-based production technology will continue to grow as companies form partnerships in areas like oil & gas, packaging and food & beverage.

Case in point: ABB and Enovate Upstream will apply their complimentary digital platforms, ABB Ability Wellhead Manager and Enovate Upstream's Digital Production, to create a fully automated and scalable, digital oilfield solution. The solution maximizes the value of assets by connecting operations with reservoir engineering through a cloud-based digital platform. The artificial intelligence (AI) production technology gives customers the opportunity to understand their production rates in real time to enable better decision-making while providing financial performance assessment and capital management.

The ADA AI Digital Ecosystem created by Enovate Upstream and ABB Ability Wellhead Manager are cloud-based platforms that when integrated provide oil and gas producers insight into onshore upstream production assets. This includes reservoir analysis, using a cloud-based supervisory control and data acquisition system (SCADA) and predictive analytics platform from anywhere, at anytime, on any device.

"Our collaboration with Enovate Upstream enhances our capabilities to assist customers in their digital transformation. Working together, we bring extra value to upstream customers for a total production and operations solution. Customers using our combined digital solution will have more insight into the reservoir data to make more informed decisions, ultimately driving operator effectiveness," said Nathan Tungseth, ABB global segment manager, onshore oil and gas.

"Initial results from our team during the co-development with operators and early field implementation demonstrated the substantial value creation for cost optimization, production enhancement, workflow automation and decision-making outcomes," said Camilo Mejia, CEO Enovate Upstream. "This collaboration demonstrates how our industry is embracing technology to improve efficiencies and support short- and long-term sustainability goals."

As demand for digital automation continues to increase, ABB and Enovate Upstream are creating an opportunity to further advance the collective goal of digital transformation. The combined expertise of the two entities aligns core beliefs that collaboration and digitalization are necessary for project value improvements across the energy sector.

www.abb.com

Safety First

Safer controls, components, and automation will be on full display as the industry starts coming back together face-to-face for trade shows in 2022. Some recent examples:

Intelligent Motion Solutions for Material Handling

Combining intelligent controls with some of the highest-quality linear actuators available on the market, Columbus McKinnon Corporation, a designer and manufacturer of intelligent motion solutions, products and technologies for material handling, today announced the introduction of its Duff-Norton brand SPA Linear Actuator with Intelli-Motion technology.

The latest and most advanced Duff-Norton linear actuator, the SPA with Intelli-Motion is designed to provide reliable operation, enable precision motion control and simplify applications, especially those that can benefit from automation technology. The latest product to join Columbus McKinnon's family of automation solutions, this intelligent actuator offers easy installation, configuration, and operation to ensure systems can get up and running quickly and perform reliably.

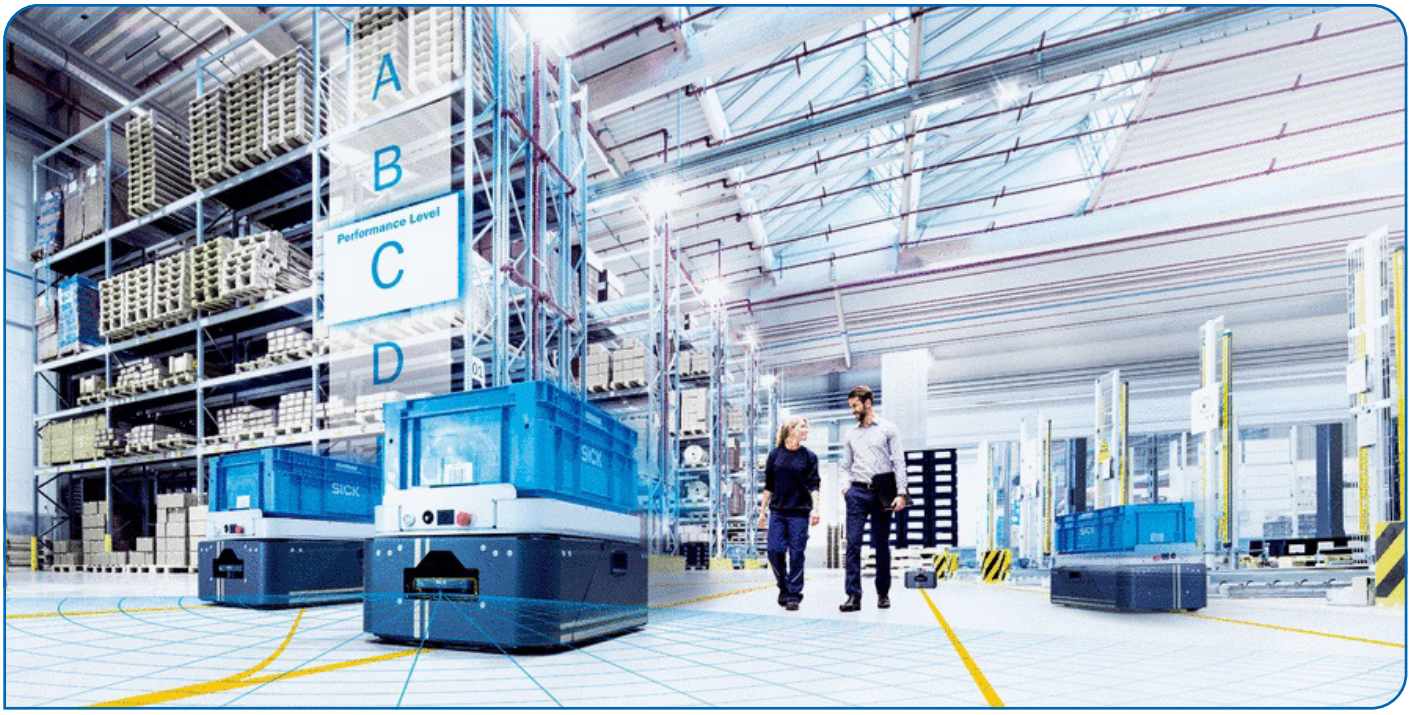
"Getting the most from a motion system means finding the right linear actuator, one that works efficiently, is durable, moves the load safely, and operates at the desired speed," says Mark Yerse, senior global product manager and strategic marketing manager. "The SPA with Intelli-Motion can do all of that and more. It is robust enough to handle higher-duty cycle applications while providing precise, repeatable motions and feedback capabilities."

www.columbusmckinnon.com

SICK Offers Safe, Solid-State Technology

The scanGrid2 safe multibeam scanner from SICK uses a novel and in-house developed solid-state LiDAR technology to increase the productivity of small autonomous and line-guided transport vehicles. Certified as a Type 2/SIL 1

Integrated teams from Enovate Upstream and ABB are working side-by-side to rapidly advance innovation needed for growth, expansion, and customer-focused solutions across the entire oil and gas industry.



SICK employed its novel and in-house developed solid-state LiDAR technology for the first time when developing its first scanGrid2 safe multibeam scanner.

safety sensor according to IEC 61496-3, the scanGrid2 can protect hazardous areas up to performance level c and works well for collision avoidance. An app and cloning function also ensure a high level of up time and fast fleet deployment.

"With this sensor, manufacturers of autonomous and line-guided autonomous vehicles gain a cost-effective safety solution that can boost the productivity of applications. Specifically, this means increasing the speed or payload of the vehicles, or being able to eliminate mechanical barriers like fences," said Aaron Woytcke, market product manager of industrial safety at SICK USA.

Conventional safety laser scanners are often not a suitable solution for these very simple and exceptionally cost-effective small vehicles for economic reasons. Users often choose between limiting the speed or payload of the vehicle or avoid operating them in unfenced areas to minimize the risks associated with the vehicles. The scanGrid2 now offers users new possibilities for successfully increasing the productivity of small autonomous and line-guided carts. Thanks to the rapid return on investment, switching to a safety sensor is now a viable option with initial installations showing productivity increases between 50 and 70%.

The scanGrid2 safely detects objects of a variety of sizes within the freely configurable protective field zones, can evaluate multiple fields, and can execute configurable monitoring cases. A warning field zone extending up to four meters beyond the safe working range can be employed for non-safety actions.

The solid-state LiDAR technology is based on the principle of time-of-flight measurement and eliminates all moving parts. Instead, the device uses only semiconductor elements in conjunction with geometrically arranged optics modules to span a protective field of 150 degrees. Within the defined protective field zone, scanGrid2 can solve Type 2 classified, performance level c safety requirements in the context of safety applications.

www.sick.com

Upgrading Cybersecurity Measures

It's incredibly important in 2021-2022 to consider implementing cybersecurity measures in conjunction with IIoT and digital factory solutions. One without the other at this point will only cause trouble down the road for technology implementation and new automation concepts. FANUC is offering retrofit control packagers to update older equipment and Emerson provides plenty of material to consider in developing your own cybersecurity package.

Retrofitting CNC Systems

FANUC America recently introduced an upgrade solution for legacy CNC machines running on operating systems older than Windows 10. The Panel *i* Replacement Program retrofits FANUC CNCs with a powerful industrial PC available with touch or non-touch LCD display, solid-state drives and Windows 10 IoT Enterprise.

FANUC CNCs running on obsolete operating systems, such as Windows 7, XP or older, are no longer supported by Microsoft and therefore not receiving their critical updates. If machines connect to an online network, this can leave sensitive manufacturing equipment open to major cybersecurity breaches.

"To stay competitive, you need real-time operational information from your CNC machines to make data-driven decisions," says Jon Heddleson, general manager of factory automation for FANUC America. "But we realize there is a lot of legacy CNC equipment still in use today. To fill this critical cybersecurity need, this program allows FANUC CNC users to unlock IIoT

FANUC America recently introduced an upgrade solution for legacy CNC machines running on operating systems older than Windows 10.

advantages by connecting their machines to the business network in a safe and secure way."

www.fanucamerica.com

Long-term security plan

Collaboration between IT and OT stakeholders is vital to implement new systems and services that help an organization digitally transform. In developing a cybersecurity strategy, IT and OT stakeholders must understand each other's strengths and how to achieve business goals whilst maintaining the highest levels of security.

Each expertise brings something different to the table, with IT having a highly standardized process and OT having a more engineered solution. The goals of both stakeholders need to be reviewed and requirements established to avoid gaps and risk to operations. Automation suppliers can make secure deployment of systems more successful by providing a layered portfolio of security controls, procedures and services that enhance system security and help end users prioritize cybersecurity assessments.

Organizations must consider cybersecurity during the front-end engineering and design of a control system project. Too often cybersecurity defenses are added later, and this is more expensive and rarely as effective as building cybersecurity into the project. This is referred to as the 'Shift Left' concept. Secure by design, coupled with an appropriate cyber risk analysis, should include a review of security features and controls to ensure their effectiveness against the growing cyber threat landscape.

The SPA with Intelli-Motion is designed to provide reliable operation, enable precision motion control and simplify applications.

To support the business justification of a cybersecurity initiative, assessments can be used as a risk reduction metric that represents the progress of cyber initiatives implemented thus far and the potential protection afforded by deploying additional cyber protections.

If an attack does happen, the best way to overcome it is to have a well-documented and practiced incident response plan. In short, overcoming an attack does not go well without cybersecurity features, controls and a well-thought-out plan. **PTE**

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An Idea Strengthens the Back of The World

Faulhaber

It is neither fatal nor infectious, but very difficult to manage and extremely expensive to society, i.e.—the widespread medical disorder of chronic back pain. A motorized exoskeleton can provide relief to the especially vulnerable lumbar spine. French manufacturer Japet relies on Faulhaber here, as its product demands the highest quality, and every gram counts.

Figure 1 A motorized exoskeleton can provide relief to the especially vulnerable lumbar spine.

Back pain accounts for one of every ten sick leaves and 13 percent of early retirements. 80% of people have experienced the disorder themselves and the pain is chronic for 10 to 20 percent of the total population.

These numbers come from France, where the annual follow-up costs to the economy and health system are estimated at 20 billion euros. Similar values can be found in all industrial countries.

Adverse strain and continuous overloading of the spine are by far the most common causes for chronic back pains. The improper strain can actually easily be avoided by observing one simple rule: always lift loads with the knees and while keeping the upper body upright. In daily life and with many jobs, this rule can, however, often be difficult to follow. Helping a patient out of bed, lifting a postal package out of the car, handling heavy parts in a production process or working with heavy, portable machines on a construction site can make it extremely difficult to keep back strain in the ergonomically correct range. The lifted weight then unavoidably presses on a flexed spine.

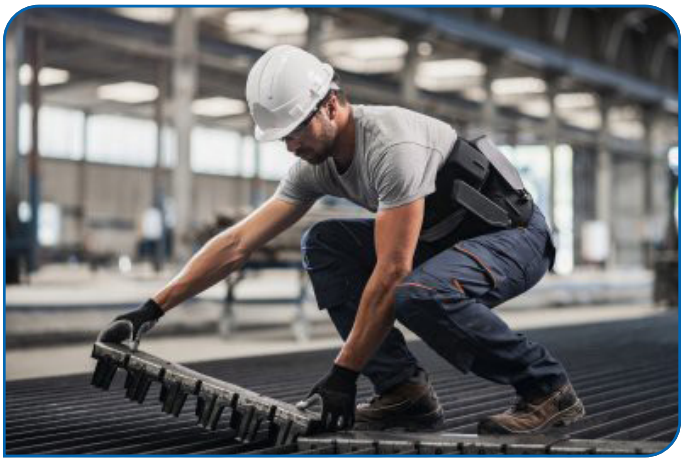

Figure 2 Adverse strain and continuous overloading of the spine are by far the most common causes for chronic back pains.

Negative leverage effect aggravates the problem

The leverage effect is extremely negative here: depending on the degree of bending, a 22+ pounds package can press an equivalent force of up to 110+ pounds on the lumbar discs of the lower spine. While these natural shock absorbers made of fibrocartilage are exceptionally tough and resilient, they age over time, and, when constantly subjected to improper strain, can wear prematurely: they shrink, the damping effect subsides and the adjacent bone tissue also changes—often with painful consequences. In the case of a slipped disc, the intervertebral disc actually ruptures, the core slips out and presses extremely painfully against the surrounding nerves.

"If the improper strain cannot be consistently avoided,

Figure 3 The exoskeleton Japet.W consists essentially of two belts that are connected to one another by four actuators.

Figure 4 It is, above all, the excessive strain on the intervertebral discs while in a bent position that is thereby significantly reduced or avoided completely.

measures that provide relief must be considered," says Japet's Antoine Noel. In 2015, the robotics engineer, together with Amelie Blondeaux and Damien Bratic, founded the company Japet in Lille. "Our objective was to develop an active support corset for the lumbar spine. Undesirable strain should be compensated for by motor power, thereby protecting the intervertebral diiscs."

Relief through actuators

The result of their work is the exoskeleton Japet.W. It consists essentially of two belts that are connected to one another by four actuators — two on each side of the body. The upper belt supports the back, the lower belt is seated on the hips. The actuators are so-called series-elastic actuators (SEA). They "feel" a force that is acting upon them and use their own motor power to counter it.

Their most important elements are a motor, a lead screw and a spring. A potentiometer measures the applied force, for example, if the wearer of the exoskeleton bends forward and picks up a weight. This measurement signal puts the motor, which is coupled to the drive lead screw by a gearhead, into operation. The turning of the lead screw transfers the motor power to the spring. It presses from the lower belt on the upper belt, supports the upper body and relieves the lumbar spine. With respect to the level of relief provided by the exoskeleton, the wearer can select from four levels. The controller and the battery of the device are integrated in the double belt.

"The hips experience only a slight additional strain as a result of the added pressure; they are, in any case, able to

Figure 5 Because the device is, of course, worn on the body to which it is to provide relief, every gramme matters here — at 18 g per motor, the drives account for just a fraction of the total weight.

withstand even heavier weights without problem," explains Noel. "The force that acts on the lumbar spine is, on the other hand, greatly reduced. It is, above all, the excessive strain on the intervertebral discs while in a bent position that is thereby significantly reduced or avoided completely. At the same time, the position of the upper body is also improved."

Micromotors lift four cars

The founders of Japet first met Faulhaber at a trade fair. At that time, their company was still a technical testing lab in a side room of a clinic in northern France. The first sale was still in the distant future. In their first test devices, the three young entrepreneurs had installed inexpensive and noisy motors that could be controlled only poorly. The experts from Faulhaber took a liking to the ideas of the young engineers. They supported them with intensive consulting and prototypes of high-quality motors that could meet the needs of the demanding application. "That played a big part in making our product ready for series production," emphasizes Noel.

In the Japet.W exoskeleton, four DC-motors with precious metal commutation of the 1524…SR series supply the supporting force for relieving the spinal column. Responsible for the load transmission are planetary gearheads of the 15A series with a reduction of 52:1. Because the device is, of course, worn on the body to which it is to provide relief, every gram matters here — at 18 g per motor, the drives account for just a fraction of the total weight. Nevertheless, they are strong enough to relieve the intervertebral discs the weight of three to four medium-sized cars over the course of a workday.

In addition to the ratio between volume and force, quality and reliability are among the key decisive criteria for Japet. "The exoskeleton is a certified medical product," explains Noel. "The highest standards apply here. Moreover, the device must support its wearer in continuous operation, over a long period of time and, ideally, with no maintenance. This is made possible with the drives from Faulhaber."

The Japet.W has now been on the market for over a year. It is already used in numerous industries, including the railway industry, in construction and in medical care. Its use serves to counter the possible development of chronic back pain. It is, however, also used by people who have already developed this syndrome and are searching for a way to continue to work. "75% of all wearers who had previously developed back pain while working report from an effective reduction in pain," emphasizes Noel. "That is a noteworthy value from a medical perspective, especially as chronic back pains are a very persistent and difficult to treat condition. Because we all tend to work longer and because the know-how of the older employees is becoming increasingly more valuable, the exoskeleton has great potential from an economic vantage point as well." **PTE**

www.FaulhaberUSA.com

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Power Transmission Engineering

Reducing Plant Downtime

Win-911 Examines Critical Role of Remote Alarm Notification Software

Greg Jackson, CEO, Win-911

Moving from an automated plant to a smart factory is a leap forward but well worth the effort to enable a fully connected and flexible system—one that can use a constant stream of data from connected equipment and production systems to learn and adapt to new demands (*www.2deloitte.com*).

Manufacturing plants are facing a convergence of extreme challenges: an aging workforce coupled with the transfer of knowledge, increased demands for higher quality products utilizing fewer resources and the pandemic. Navigating these issues is critical to maintaining ongoing operations and controlling costs. If something additional happens, such as unplanned equipment downtime, the results can be a logistical nightmare and financial disaster. But it's certainly not all doom-and-gloom. Recent trends in IIoT, machine connectivity, and monitoring solutions are playing a critical role in mitigating unexpected problems and staffing challenges.

Manufacturing is moving from reactive to a more controlled system maintenance approach.

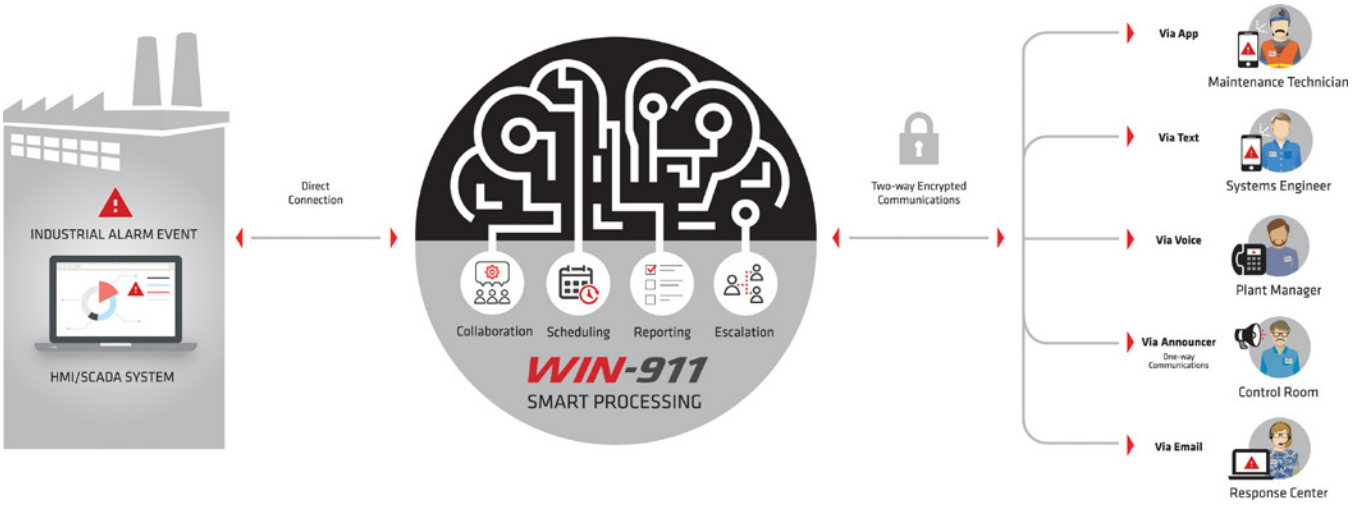
Manufacturing Workforce

U.S. manufacturing is in the thick of an expected shortage of two million workers between 2015–2025, according to a report from Deloitte and the Manufacturing Institute (*Food Engineering*). This has only been exacerbated by the pandemic. In the latest report by Deloitte and the Manufacturing Institute, as many as 2.1 million manufacturing jobs will be unfilled through 2030. The report warns the worker shortage will hurt revenue, production and could ultimately cost the US economy up to $1 trillion by 2030 (www.manufacturinginstitute.org). The study's dramatic findings come from online surveys of more than 800 U.S.-based manufacturing leaders, as well as interviews with executives across the industry and economic analyses.

A 2017 industry study sponsored by Advanced Technology Services found that the leading cause of unscheduled downtime within respondents' facilities was aging equipment (42 percent), followed by operator error (19 percent) and lack of time needed to perform necessary maintenance (13 percent). Of all the core disciplines affected by the shortage of trained personnel, machine maintenance may be the most troublesome for manufacturing plants. Thirty-five percent of U.S. manufacturers are currently seeking maintenance technicians, and an even higher percentage are shifting at least some maintenance responsibilities to operating personnel—a potentially dangerous tactic at a time when equipment is becoming increasingly automated and complex.

According to the National Association of Manufacturers' outlook survey (*www.nam.og*) attracting and retaining a quality workforce constitutes one of the top challenges facing the manufacturing industry. This industry faced a labor shortage exacerbated by the aging of the [manufacturing] workforce and gradual retirement of the baby boomer generation—as of 2017, nearly one-quarter of the sector's workforce are age 55 or older. Additionally, 97 percent of respondents reported that they feared losing institutional knowledge when [older] workers depart. The study also examined the innovative approaches manufacturers can use to extend older workers' productivity and help transfer institutional knowledge to the next generation.

Manufacturing jobs are becoming more complex, including the maintenance of the hi-tech plant equipment. However, the answer to the labor shortage and transfer of knowledge may be rooted in additional technology.



WIN-911 remote monitoring software utilizes a variety of communication platforms to send notification from the plant equipment to the person responsible.

Unplanned Downtime

Millions of dollars are invested each year in capital improvements to facilities and equipment to increase product safety, protect employees and reduce costs, which is important since equipment in a typical food processing plant, for example, may run 16 to 20 hours a day, every day — or even 24/7. Equipment failure is the most common cause for downtime. According to analyst firm Aberdeen Research, downtime costs manufacturing facilities an astounding $260,000 per hour (*IIoT World*). A Deloitte industry report cited recent studies that show unplanned downtime costs industrial manufacturers an estimated $50 billion annually. However, downtime can cost a company more than just money — it can be a logistical nightmare.

As the world continues to grapple with COVID-19 and supply chain issues, manufacturing plants are under more pressure than ever to maintain ongoing operations. However, given that maintenance worker shortages existed even before the pandemic, what can plants do to mitigate unplanned downtimes?

Sensors and SCADA

One strategy to help resolve this is for manufacturing plants to invest in technology for areas with worker shortages, such as sensors that monitor whether a machine is working properly instead of having someone possibly crawl under equipment to check out a problem.

Sensors pick up on performance aberrations that simply can't be detected through manual spot checks and personnel monitoring. By detecting the underpinnings of potential issues in real-time, sensors can alert maintenance teams of the need to investigate to prevent a machine failure before it happens.

Supervisory Control and Data Acquisition (SCADA) is a system of hardware and software elements used to control processes both locally and remotely. They are crucial for organizations as they help maintain efficiency, process data for more well-informed decisions, and communicate system issues to help mitigate loss and downtime. SCADA systems perform:

- Data Acquisition and Communication
- Information and Data Presentation
- Monitoring and Control

These functions are performed by sensors, remote terminal units (RTUs), controllers, and a communication network. The sensors collect the information, RTUs send the information to the controller, which displays the status of the system. The operator can then give commands to the components of the system depending on the status (www.jonecarter.com).

SCADA systems allow communication between the operator and the connected devices. Real-time systems have thousands of components and sensors, each gathers data and helps ensure that every part of a facility is running effectively. The real-time applications can also be controlled remotely. Access to real-time information allows entities to make data-driven decisions about how to improve processes. Without SCADA, it would be difficult to gather sufficient data for consistently well-informed decisions (www.jonescarter.com).

Remote Monitoring

Another way to reduce unplanned downtime is with remote alarm notification software, which allows fewer people to monitor many more assets using devices that people already have, such as smartphones and tablets. Uninterrupted remote availability is essential to ensuring systems can be continuously monitored, even without staff onsite or with fewer people working at the facility.

Remote monitoring of critical plant systems has been extended beyond email, texts and phone calls to include apps that feature time-saving tools like real-time alarm acknowledgements, team chats to troubleshoot and resolve plant problems, and detailed reporting for preventing future incidents. Not only does this mean fewer emergency shutdowns, but also fewer resources spent on overtime and maintenance.

A mobile alarm notification app is software that seamlessly integrates with the SCADA or HMI software of an industrial operation, allowing an employee to monitor, receive and acknowledge plant and machine alarms on their smartphones or tablet, freeing them up to work from home or any other remote location. Hardware and

software are available that can constantly monitor equipment and, by applying machine learning to historical data, warn when a breakdown or other problem is imminent. Bolstered by wireless technology and IIoT, these customizable systems have the potential to bring predictive maintenance to a new level.

The benefits of utilizing a remote monitoring and notification software system via a mobile app include:

Streamlines decision making. Push notifications let users quickly see what is wrong, send an acknowledgment, and monitor alarm condition changes in real-time, right from smartphones.

Promotes team problem solving. Chat helps the entire team converse, brainstorm, and share solutions on-the-fly, from anywhere — whether in the plant, at home, or on the road.

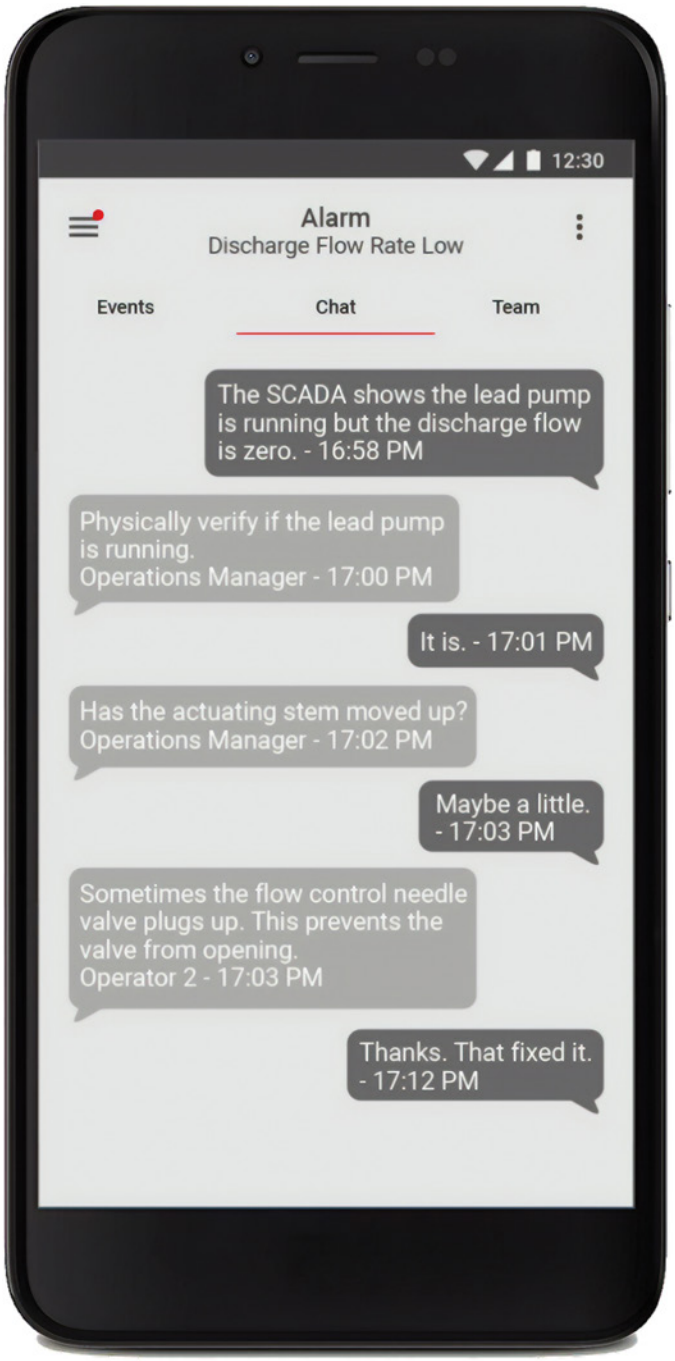
Work more efficiently. Team Visibility shows who has seen an alarm as well as who has acknowledged it, reducing guesswork and redundant responses.

Multiple communication channel support. Ensuring resiliency through voice notification and SMS messaging in the event of internet connectivity issues.

Critical Need

Manufacturing plants in a variety of industries have become more critical than ever before. For example, pharmaceutical companies manufacturing COVID-19 vaccines, medical refrigeration manufactures, food processing plants, and other industries that are retooling and manufacturing under the Defense Production Act are all essential during these unprecedented times. Through the installation of remote alarm notification software, manufacturers can move from reactive to a more controlled, prescriptive maintenance approach. **PTE**

www.win911.com



Chat helps your entire team converse, brainstorm, and share solutions on-the-fly, from wherever they are — whether in the plant, at home, or on the road.

Greg Jackson is CEO of Austin, TX-based WIN-911 and may be reached at greg.jackson@win911.com or 512-326-1011. The company helps protect over 18,000 facilities in 80 countries by delivering critical machine alarms via smartphone or tablet app, voice (VoIP and analog), text, email, and in-plant announcer, reducing operator response times, system downtime, and maintenance costs. Prior to becoming CEO five years ago, Jackson held leadership positions in international sales, business development, operations, and product development.

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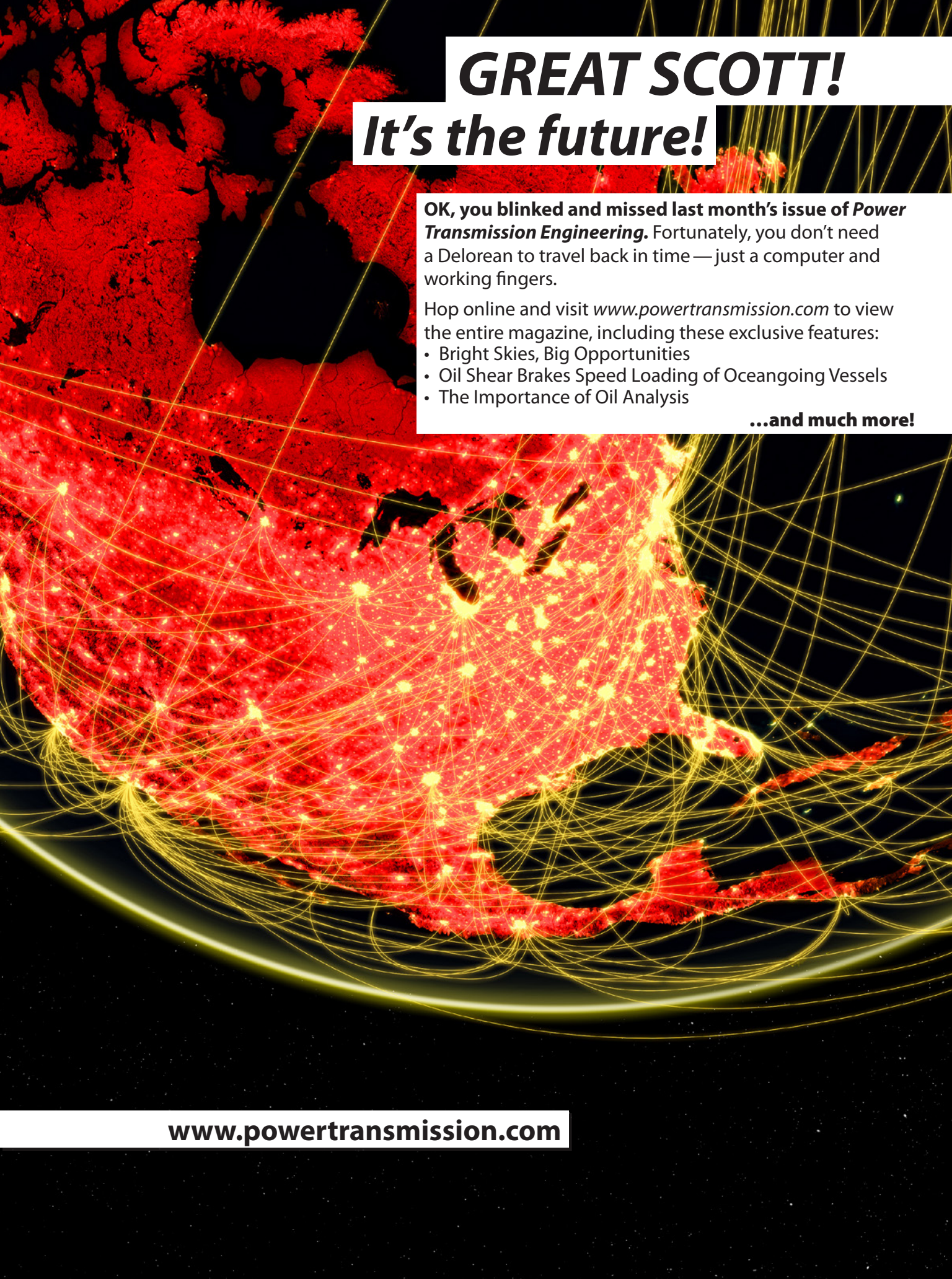

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Toll Free: 800-819-8900
Fax: 516-326-8827

Email: sdp-sisupport@sdp-si.com

www.sdp-si.com

2021 *PTE* Buyers Guide

About This Directory

The 2021 *Power Transmission Engineering* Buyers Guide was compiled to provide you with a handy resource containing the contact information for significant suppliers of power transmission components.

Bold Listings throughout the Buyers Guide indicate that a company has an advertisement in this issue of *Power Transmission Engineering*.

How to Get Listed in the Buyers Guide

Although every effort has been made to ensure that this Buyers Guide is as comprehensive, complete and accurate as possible, some companies may have been inadvertently omitted. If you'd like to add your company to the directory, we welcome you. Please visit *www.powertransmission.com/getlisted.php* to fill out a short form with your company information and Buyers Guide categories. These listings will appear online at *www.powertransmission.com*, and those listed online will automatically appear in next year's printed Buyers Guide.

Handy Online Resources

The *Power Transmission Engineering* Buyers Guide – The listings printed here are just the basics. Visit our online buyers guide for the most comprehensive directory of suppliers of gears, bearings, motors, clutches, couplings, gear drives and other mechanical power transmission components, broken down into sub-category by type of product manufactured:

www.powertransmission.com/directory/

The Gear Industry Buyers Guide – If you manufacture gears or need information on suppliers of machine tools, tooling and services for gear manufacturers, please visit the buyers guide on *Gear Technology's* website:

www.geartechnology.com/dir/

ACCESSORIES

ABB Motors and Mechanical Inc.
www.baldor.com

ABL Products Incorporated
www.ablproducts.com

Accent Bearings Co. Inc.
www.accentbearing.com

Ace World Companies
www.aceworldcompanies.com

Acorn Industrial Services Ltd.
www.acorn-ind.co.uk

Advanced Technology Services, Inc.
www.advancedtech.com

Advanced Test & Automation Inc.
www.advancedta.com

Aerotech Inc.
www.aerotech.com

Affiliated Distributors
www.adhq.com

AGI Automation Components
www.agi-automation.com

AIMS Industrial Supplies
www.aimsindustrial.com.au/

AISCO Industrial Couplings
www.aiscoinc.com

Akron Gear and Engineering
www.akrongear.com

All-Pro Fasteners, Inc.
www.apf.com

Allied International
www.alliedinter.com

Amacoil, Inc.
www.amacoil.com

Ametric / American Metric Corporation
www.ametric.com

AmTech International
www.amtechinternational.com

Andec Mfg. Ltd.
www.andec.ca

Applied Dynamics
www.applied-dynamics.com

Area Distributors Inc.
areadist.com

Artec Machine Systems
www.artec-machine.com

Ascent Precision Gear Corporation
www.ascentgear.com

Ashutosh Power TransBelts Limited
www.aptbelts.com

ASI Technologies Inc.
www.asidrives.com

AST Bearings
www.astbearings.com

Atlanta Drive Systems Inc.
www.atlantadrives.com

ATO Inc.
www.ato.com

Avalon International Corp.
www.avalongateway.com

AV Industrial Products Ltd
www.avindustrialproducts.co.uk

Axu s.r.l.
www.axu.it

B&B Manufacturing, Inc.
www.bbman.com

Baart Industrial Group
www.baartgroup.com

Bartlett Bearing Company, Inc.
www.bartlettbearing.com

BDI - Bearing Distributors Inc.
www.bdiexpress.com

Bearing Boys Ltd
www.bearingboys.co.uk

Bearing Engineering Company
bearingengineering.com

Bearing Headquarters
www.bearingheadquarters.com

Bearings and Industrial Supply Company, Inc.
www.bearingsnow.com

Bearing Service Company
www.bearing-service.com

Bearings Limited
www.bearingslimited.com

Bevel Gears India Pvt. Ltd.
bevelgearsindia.com

Bishop-Wisecarver Corp.
www.bwc.com

BK Power Systems - An Integrated Corrosion Co.
www.bkpowersystems.com

BRECOflex CO., L.L.C.
www.brecoflex.com

Brewer Machine & Gear Co.
www.brewertensioner.com

BSF, Inc.
www.bsfinc.net

C-Flex Bearing Co., Inc.
www.c-flex.com

Cable Manufacturing and Assembly
www.cmacable.com

Canto Engineering Company
www.cantoengineering.com

CCTY Bearing
www.CCTYBearing.com

CENTA Power Transmission
www.centa.info

Challenge Power Transmission (Aust) Pty Ltd
www.challengept.com

Challenge Power Transmission PLC
www.challengept.com

Checkfluid
www.checkfluid.com

Cleveland Gear Co.
www.clevelandgear.com

Collars and Couplings Inc.
www.collarsandcouplings.com

ComInTec
www.comintec.com

Comtec Mfg., Inc.
www.comtecmfg.com

Cramlington Precision Forge Limited
www.cpfl-tvs.com

Cross + Morse
www.crossmorse.com

C R Products Ltd.
www.c-rproducts.com

Currie Enterprises
www.currieenterprises.com

Custom Machine & Tool Co. Inc.
www.cmtco.com

Cyclo-Index
www.cycloindex.com

Daemar Inc.
www.daemar.com

Daido Corporation of America
www.daidocorp.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Darbar Belting
www.darbarbelting.co.in

Datasyst Engineering & Testing Services, Inc.
www.datasysttest.com

Daubert Cromwell LLC
www.daubertcromwell.com

Davall Gears Ltd.
www.davall.com

David Brown Santasalo Canada Service Inc.
www.dbsantasalo.com

Del-Tron Precision Inc.
www.deltron.com

Distag QCS
www.distag.com

Dover Motion
www.dovermotion.com

Drive Components LLC
www.drivecomponentsllc.com

Drive Systems Technology Inc.
www.gear-doc.com

Dynatect Manufacturing Inc. (fka A & A Mfg.)
www.dynatect.com

Eagle PLC
www.eagleplc.com

Electro Steel Engineering Company
www.fenner.in

Elkem Silicones
www.silicones.elkem.com

Emerson Industrial Automation - Drives & Motor
www.emerson.com/en-us/automation-solutions

Ensinger Precision Components
www.plastockonline.com

EquipNet
www.equipnet.com

Filter Pumper / Hydraulic Problems, Inc.
www.filterpumper.com

Fixtureworks
www.fixtureworks.com

Flux Drive Inc.
www.fluxdrive.com

Force Control
www.forcecontrol.com

Forgital Group
www.forgital.com

Framo Morat Inc.
www.framo-morat.com

Friel Metal Resurfacing
www.frielmetalresurfacing.com

Functional Oil Seal Industrial Co., Ltd. - FOS
www.fos.com.tw

G.L. Huyett
www.huyett.com

Gallagher Fluid Seals, Inc.
www.gallagherseals.com

Gates Corporation
www.gates.com

Gayatri Gear Industries
www.gayatrigear.com

Gear Master Inc.
www.gearmaster.us

GearTec
www.geartec.com

Gibbs Gears Precision Engineers
www.gibbsgears.com

Gleason Plastic Gears
www.gleason.com

Hangzhou Shengda Bearing Co
www.china-sda.com/product/draglink/

Hangzhou Xingda Machinery Co. Ltd.
www.xdmade.com

Hayes Manufacturing Inc.
hayescouplings.com

HBM
www.hbm.com

Heidenhain Corporation
www.heidenhain.com

Hi-Grade Inc.
www.higradeinc.com

Highfield Gears and Machining Ltd.
www.highfieldgears.co.uk

HVH Industrial Solutions
hvhindustrial.com

IBT Industrial Solutions
www.ibtinc.com

IDA Motion Inc.
www.idamotion.com

IKO International Inc.
www.ikont.com

Impro Industries USA, Inc.
www.improprecision.com

IMS LLC
www.intermotionsupply.com

Industrial Automation Co.
www.industrialautomation.co

Industrial Pulley & Machine Co, Inc.
www.industrialpulley.com

Industrial Spares Manufacturing Co.
www.industrialsparesfromindia.com

Intech Corporation
www.intechpower.com

Integrated Components Inc.
www.integratedcomponentsinc.com

Intellidrives, Inc.
www.intellidrives.com

Involute Powergear Pvt. Ltd.
www.involutetools.com

ISC Companies
isccompanies.com

J.W. Winco Inc.
www.jwwinco.com

Jason Industrial Inc.
www.jasonindustrial.com

jbj Techniques Limited
www.jbj.co.uk

Juncera Automations
junceraautomations.com

JVL Industri Elektronik A/S
www.jvl.dk

K+S Services
www.k-and-s.com

KBK Antriebstechnik Gmbh
www.kbk-antriebstechnik.de

KEB America, Inc.
kebblog.com

Kiesler Machine Inc.
www.kieslermachine.com

Kinematics Manufacturing, Inc.
www.kinematicsmfg.com

Kluber Lubrication North America L.P.
www.kluber.com

Kollmorgen
www.kollmorgen.com

KTR Corporation
www.ktr.com

Lafert North America
www.lafertna.com

LM76 Linear Motion Bearings
www.LM76.com

Lovejoy, Inc. (A Timken Brand)
www.lovejoy-inc.com

Luco Power Transmission Co. Ltd.
www.lucopt.com

Machine Guard & Cover Co.
machineguard.com

Machinists Inc.
machinistsinc.com

Magnum Manufacturing
magnum-mfg.com

Magtrol, Inc.
www.magtrol.com

Maguire Technologies
www.maguiretech.com

Malloy Electric
www.MalloyWind.com

Martin Sprocket & Gear
www.martinsprocket.com

MasterDrive, Inc.
www.masterdrives.com

Maurey Manufacturing Corporation
www.maurey.biz

Maxcess
www.maxcessintl.com

Maxon Precision Motors
www.maxonmotorusa.com

Metal Powder Products
mppinnovation.com

Metric & Multistandard Components Corp
www.metricmcc.com

MFG Components Oy
www.mfg.fi

Micronor Inc.
www.micronor.com

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www.mccchain.com.tw

Minsk Gear Works
www.mgw.by

MIR Belting
www.mir-belting.com

Mitsuboshi Belting LTD/MBL (USA) Corp
www.mblusa.com

MMB Bearing Co. Inc.
www.mmbbearings.net

MMR Precision Gears
www.mastermachinerepair.com

Motion Industries
www.motionindustries.com

Moventas Ltd.
www.moventas.com

MPT Drives, Inc.
www.mptdrives.com

MRO Electric and Supply
www.mroelectric.com

MROSupply
www.mrosupply.com

Muratech Engineering Company
www.muracopower.co.in

MW Components
www.mwcomponents.com

Nichiei Company, Ltd.
www.nichiei-ind.com/english/index.html

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northwestmotor.com

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www.novotecargentina.com

NSK Corporation
www.nskamericas.com/en/industries/industrial/power-transmission.html

Ondrives US Corp.
www.ondrivesus.com

Onvio LLC
www.onviollc.com

Orttech
www.orttech.com

P.T. International Corp. (PTI)
www.ptintl.com

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www.pi-usa.us

PIC Design
www.pic-design.com

Pinpoint Laser Systems
pinpointlaser.com

Pioneer Motor Bearing Co.
www.pioneer1.com

Pix Transmissions Limited
www.pixtrans.com

Plastock - Putnam Precision Molding, Inc.
www.plastockonline.com

Potomac Electric
www.potomacelectric.com

Precipart
www.precipart.com

Productivity Inc.
www.productivity.com

Pulley Manufacturers International Inc.
www.pulleys.com

QA1
www.qa1.net/industrial

Quality Bearings & Components
www.qbcbearings.com

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www.renebaerag.ch

Renishaw Inc.
www.renishaw.com

Resistoflex Private Limited
www.resistoflex.in

RGW Sales Canada
www.rgwsalescanada.com

Ringball Corporation
www.ringball.com

Ringfeder Power Transmission USA Corp.
www.ringfeder.com

Ringspann Corporation
www.ringspanncorp.com

Ritbearing Corp.
www.ritbearing.com

Rockwell Automation
www.rockwellautomation.com

Romax Technology Limited
www.romaxtech.com

Rotor Clip Company, Inc.
www.rotorclip.com

Rubena a.s.
www.rubena.cz

Ruland Manufacturing Co., Inc.
www.ruland.com

Schenck USA
www.schenck-usa.com

Servometer / MW Components
www.servometer.com

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www.syptworld.com

Shijiazhuang CAPT Power Transmission Co., Ltd
www.chssb.com

Sichuan Mighty Machinery Co. Ltd.
www.sc-mighty.com

Simatec Inc.
www.simatec.com

SIPCO
www.sipco-mls.com

SKF USA Inc.
www.skf.com

SMT - Smart Manufacturing Technology
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Sprockets Australia Pty. Ltd.
sprocketsoz.com.au

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www.spxcooling.com

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Team Industries
www.team-ind.com

Technico
www.technico.com

Therm-X
www.therm-x.com

Thomson Industries Inc.
www.thomsonlinear.com

Torque Transmission
www.torquetrans.com

Transmission Developments Co (GB) Ltd
www.transdev.co.uk

Transply Inc.
www.transply.com

Trojon Gear Inc.
www.trojon-gear.com

TSS Rotterdam B.V.
www.tssr.nl

Tsubaki of Canada Limited
www.tsubaki.ca

Turbo Couplings Co. Ltd.
www.turbokaplin.com.tr

TVT America, Inc.
www.tvtamerica.com

Twin Spring Coupling LLC
www.twinspringcoupling.com

U.S. Tsubaki
www.ustsubaki.com

United Gear Works
unitedgearworks.com

USA Borescopes
www.USABorescopes.com

VCST LP
www.vcst.be

Vision Quality Components, Inc.
www.visionqci.com

VL Motion Systems Inc.
www.vlmotion.com

Voith Turbo Inc.
voith.com/usa/en/index.html

W.M. Berg
www.wmberg.com

Wajax
www.wajax.com

Warner Linear
www.warnerlinear.com

WD Bearing America
www.wd-bearings.com

Whitmore
whitmores.com

Whittet-Higgins Company
whittet-higgins.com

WJB Group
www.wjbgroup.com

WMH Transmissions Ltd
www.wmh-trans.co.uk

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Zerelli Technologies Inc.
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ACTUATORS

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www.acmegear.com

Acorn Industrial Services Ltd.
www.acorn-ind.co.uk

Aerotech Inc.
www.aerotech.com

Affiliated Distributors
www.adhq.com

AGI Automation Components
www.agi-automation.com

Agnee Transmissions (I) Pvt Ltd
www.agneetransmissions.com

Agro Engineers
www.agroengineers.com

AIMS Industrial Supplies
www.aimsindustrial.com.au/

Akgears, LLC
www.akgears.com

Allied Motion
www.alliedmotion.com

Althen Sensors & Controls
www.althensensors.com

Amacoil, Inc.
www.amacoil.com

Ametric / American Metric Corporation
www.ametric.com

Anaheim Automation, Inc.
www.anaheimautomation.com

Arnold Magnetic Technologies
www.arnoldmagnetics.com

Atlanta Drive Systems Inc.
www.atlantadrives.com

ATO Inc.
www.ato.com

Avion Technologies Inc.
www.avion-tech.com

BDI - Bearing Distributors Inc.
www.bdiexpress.com

Bearing Engineering Company
bearingengineering.com

Bearing Headquarters
www.bearingheadquarters.com

Beaver Aerospace and Defense Inc.
www.beaver-online.com

Befared
www.befared.com.pl

Bevel Gears India Pvt. Ltd.
bevelgearsindia.com

Bharat Gears Ltd.
www.bharatgears.com

Bishop-Wisecarver Corp.
www.bwc.com

BK Power Systems - An Integrated Corrosion Co.
www.bkpowersystems.com

Bosch Rexroth
www.boschrexroth-us.com

Buehler Motor, Inc.
www.buehlermotor.com

Cable Manufacturing and Assembly
www.cmacable.com

Central Gear & Machine
www.cgmatlanta.com

Control Switches International Inc.
www.controlswitches.com

Curtis Machine Co. Inc.
curtismachine.com

Dalton Bearing Service, Inc.
www.daltonbearing.com

Del-Tron Precision Inc.
www.deltron.com

Dongyang Anuze Motor Smartech Co. Ltd.
www.microgearmotor.com

Dover Motion
www.dovermotion.com

Drive Lines Technologies Ltd
www.drivelines.co.uk

Duff-Norton
www.duffnorton.com

Duff Norton Australia
www.duffnorton.com.au

Dunkermotoren USA Inc.
www.dunkermotoren.com

Dynamic Structures and Materials, Llc
www.dynamic-structures.com

Dynatect Manufacturing Inc. (fka A & A Mfg.)
www.dynatect.com

Emerson Industrial Automation - Drives & Motor
www.emerson.com/en-us/automation-solutions

Exlar Actuation Solutions (Curtiss-Wright)
www.exlar.com

Festo Corporation
www.festo.com/usa

FMC Engineering
www.fmcengineering.com

Framo Morat Inc.
www.framo-morat.com

GearTec
www.geartec.com

Gibbs Gears Precision Engineers
www.gibbsgears.com

Gil Equipamentos Industriais Ltda.
www.gil.com.br

Gleason Plastic Gears
www.gleason.com

H2W Technologies
www.h2wtech.com

Hallmark Industries Inc.
www.hallmarkind.com

Hangzhou Shengda Bearing Co
www.china-sda.com/product/draglink/

Helix Linear Technologies
www.helixlinear.com

Hidrax
www.hidrax.eu/en/

Houston Pump and Gear
www.houstonpumpandgear.com

HVH Industrial Solutions
hvhindustrial.com

IAI America, Inc.
www.intelligentactuator.com

IBT Industrial Solutions
www.ibtinc.com

IKO International Inc.
www.ikont.com

IMS LLC
www.intermotionsupply.com

Integrated Components Inc.
www.integratedcomponentsinc.com

Intellidrives, Inc.
www.intellidrives.com

ISC Companies
iscompanies.com

JoVal Machine Company
www.jovalmachine.com

Juncera Automations
junceraautomations.com

K+S Services
www.k-and-s.com

KEB America, Inc.
kebblog.com

Kinematics Manufacturing, Inc.
www.kinematicsmfg.com

Kollmorgen
www.kollmorgen.com

LYC North America Inc.
lycbearings.com

Machinists Inc.
machinistsinc.com

Malloy Electric
www.MalloyWind.com

Mavilor Motors, S.a.
www.mavilor.es

Maxcess
www.maxcessintl.com

Midwest Motion Products, Inc.
www.midwestmotion.com

Motion Industries
www.motionindustries.com

MPT Drives, Inc.
www.mptdrives.com

MROSupply
www.mrosupply.com

MW Components
www.mwcomponents.com

NGT Specialty Valves
www.ngtvalves.com

Niebuhr Gears
www.niebuhr.dk

Ningbo Zhongyi Hydraulic Motor Co. Ltd.
www.zihyd.com

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sales@nordex.com
www.nordex.com
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Northwest Electric Motor Company
northwestmotor.com

Novanta IMS
novantaims.com

Novotec Argentina SRL
www.novotecargentina.com

NSK Corporation
www.nskamericas.com/en/industries/industrial/power-transmission.html

Parker Hannifin Electronic Motion and Control
www.parker.com/ssdusa

PBC Linear
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sales@pbclinear.com
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peacosupport.com

Performance Gear Systems, Inc.
www.performance-gear.com

PI (Physik Instrumente) L.P. Piezo Actuator Nano
www.pi-usa.us

Portescap
www.portescap.com

Potomac Electric
www.potomacelectric.com

Power Electric
www.powerelectric.com

Power Jack Motion
www.powerjackmotion.com

Precipart
www.precipart.com

PST Group (Precision Screw Thread)
www.thepstgroup.com

Rex Engineering Corp.
www.rex-engineering.com

RGW Sales Canada
www.rgwsalescanada.com

Ricardo UK Ltd
www.ricardo.com

Riley Gear Corporation
www.rileygear.com

Ringball Corporation
www.ringball.com

Rockwell Automation
www.rockwellautomation.com

Rolling Motion Industries
www.rmidrive.com

S.M. Shah & Company
hydraulicvanepump.com

Schaeffler Group USA Inc.
www.schaeffler.com

Sensata Technologies
www.sensata.com

SEPAC Inc.
www.sepac.com

Serapid Inc.
www.serapid.com

Servometer / MW Components
www.servometer.com

Sesame Motor Corp.
www.sesamemotor.com.tw

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www.chssb.com

SIPCO
www.sipco-mls.com

SKF USA Inc.
www.skf.com

Southern Gear & Machine
www.southerngear.com

Spiroid Gearing
www.spiroidgearing.com

SPN Schwaben Praezision
www.spn-hopf.de

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www.tvtamerica.com

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www.c-var.com

Venture Mfg. Co.
www.venturemfgco.com

VL Motion Systems Inc.
www.vlmotion.com

Voith Turbo Inc.
voith.com/usa/en/index.html

Wajax
www.wajax.com

Warner Linear
www.warnerlinear.com

WEG
www.weg.net

Wittenstein
www.wittenstein-us.com

Yantai Bonway Manufacturer Co. Ltd.
www.bonwaygroup.com

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ABB Motors and Mechanical Inc.
www.baldor.com

ABM DRIVES INC.
abm-drives.us/

Ace World Companies
www.aceworldcompanies.com

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www.acmegear.com

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www.acorn-ind.co.uk

Aerotech Inc.
www.aerotech.com

Affiliated Distributors
www.adhq.com

Agro Engineers
www.agroengineers.com

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www.aimsindustrial.com.au/

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www.aiscoinc.com

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www.akgears.com

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www.andantex.com

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www.applied-dynamics.com

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www.asidrives.com

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www.axu.it

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www.bdiexpress.com

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www.c-rproducts.com

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Cutes Corporation
www.cutes.com.tw

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www.eagleplc.com

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Emerson Industrial Automation - Drives & Motor
www.emerson.com/en-us/automation-solutions

Engifield Engineering
engifield.com

Essential Power Transmission Pvt. Ltd.
www.esenpro.com

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www.fluxdrive.com

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www.gibbsgears.com

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www.hoffmann-tech.ch

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mppinnovation.com

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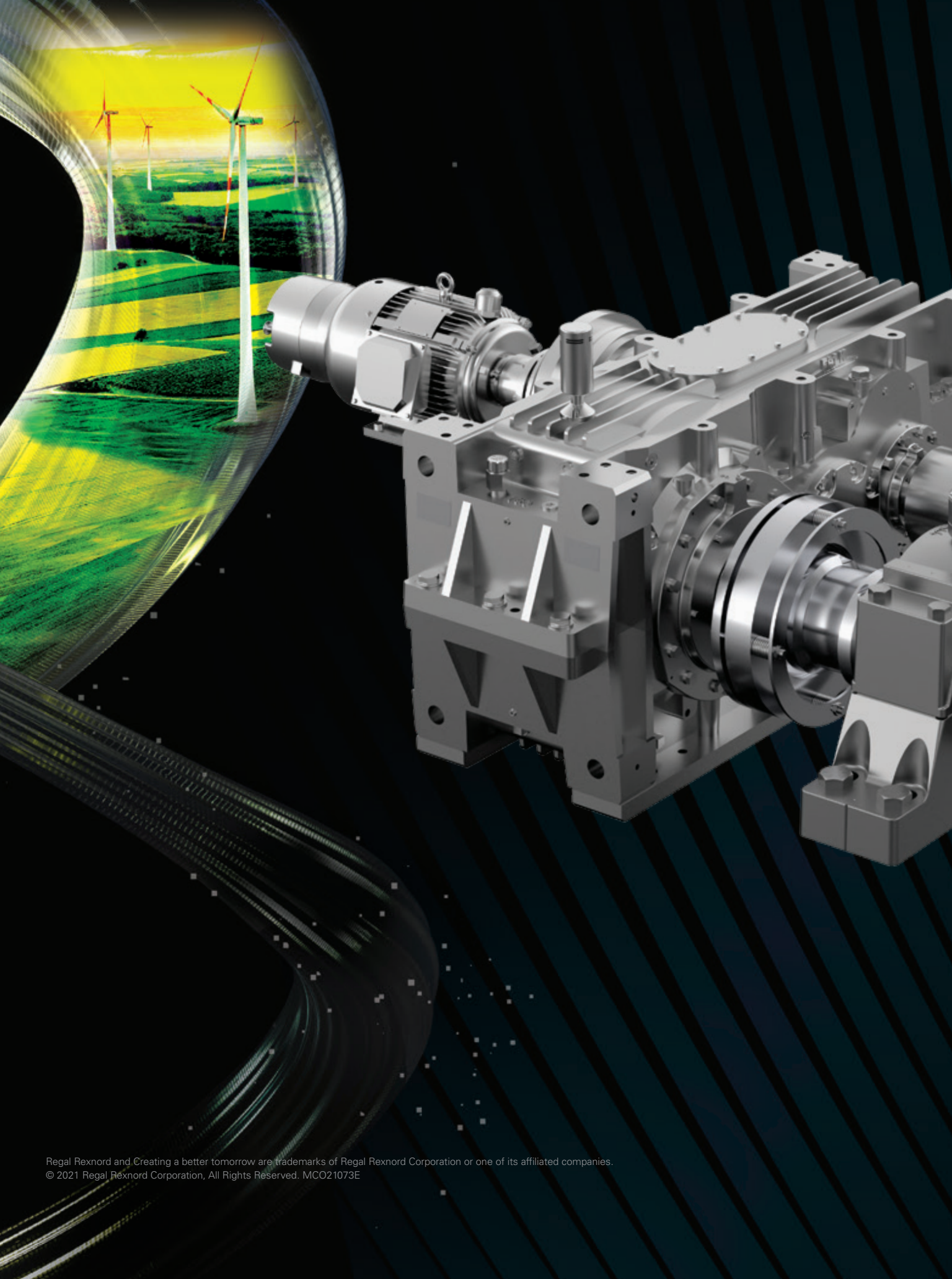

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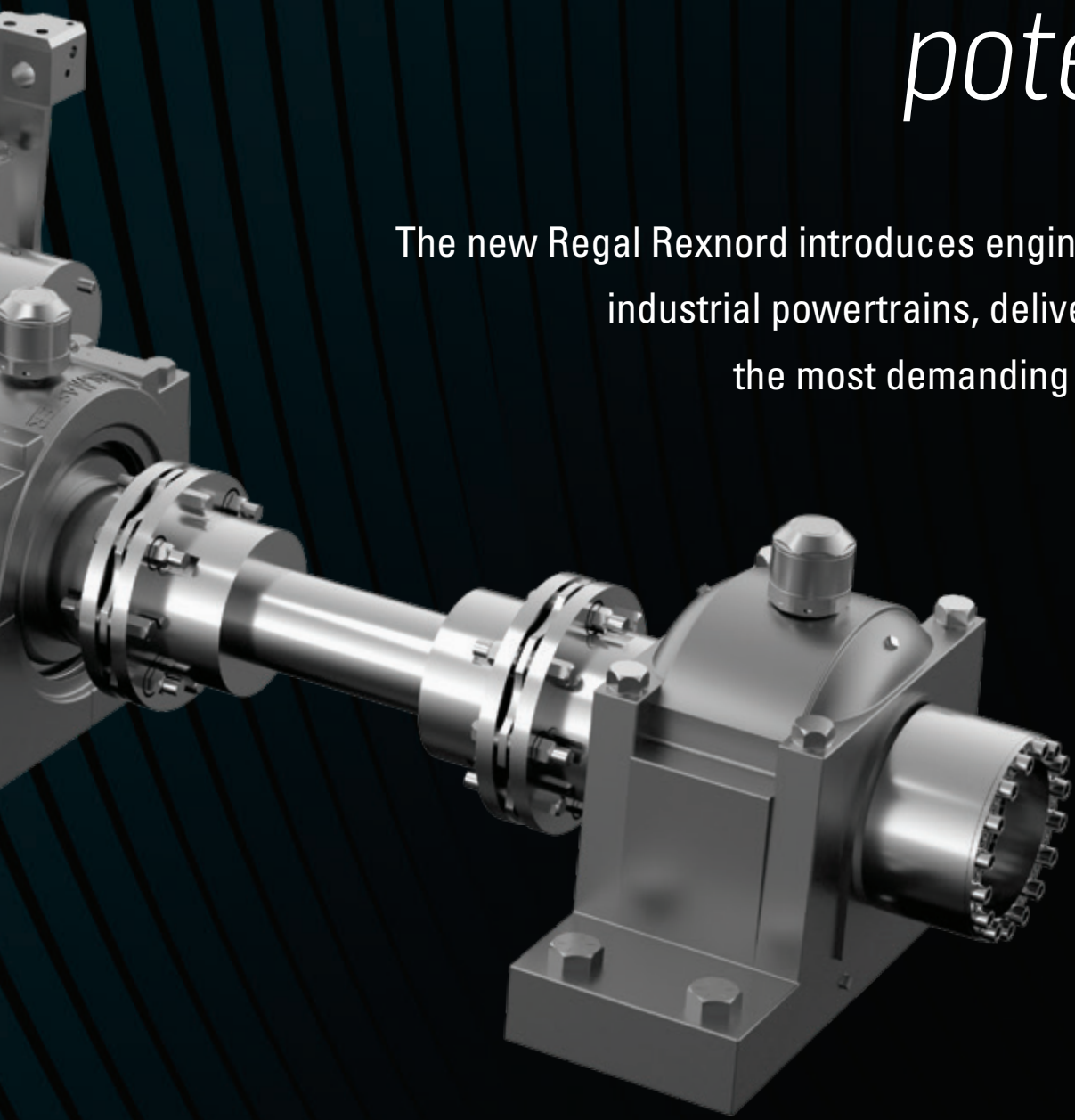

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www.ronsongears.com.au

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Shreecon Gear
shreecongear.com

Sichuan Mighty Machinery Co. Ltd.
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SIPCO
www.sipco-mls.com

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Sokhi Heli-Wom Gears Pvt. Ltd.
www.gearboxindia.com

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SPN Schwaben Praezision
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www.duffnorton.com

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www.dunkermotoren.com

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www.durabondslide.com

Dynamic Structures and Materials, Llc
www.dynamic-structures.com

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www.fmcengineering.com

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www.helixlinear.com

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HVH Industrial Solutions
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Influence of the Load-Dependent Center Distance

Benjamin Abert

High power density, combining maximum power with the lowest possible mass, requires the use of lightweight materials such as aluminum, magnesium, or plastic. However, these materials have significantly lower stiffness compared to steel. As the mass of a shaft increases by the square of its diameter, even a small reduction in the diameter can reduce the overall mass. All of these measures lead to increased softness of the system, and therefore to more severe deformations.

In tooth contact, the meshing forces always act along the path of contact at an angle to the center distance corresponding to the pressure angle. The meshing forces act on the shafts and the bearing system, leading to deformation of the system in the direction of the meshing force.

The deformations acting on the gear teeth can be obtained by dividing the shaft bending line into perpendicular sections in the direction of the center distance. Generally speaking, only the deformations arising perpendicular to the mesh are of interest, as these can lead to misalignment of the gears. These deformations should be compensated for with standard modifications, since misalignment can lead to increased loads and significantly reduced service life.

The deformations in the direction of the center distance cannot be corrected and do not have a direct effect on the load carrying capacity, as would be the case if the gears were tilted toward each other. However, this type of deformation acts similar to a change in the center distance. Therefore, the portion of the shaft bending line in the direction of the center distance is referred to in this article as the load-dependent center distance.

Definition of the load-dependent center distance

The load-dependent center distance leads to a change in the mesh, as the gears are either pulled out of or pushed into the mesh, depending on the system. This results in a change to the length of the path of contact and the contact ratio.

The Model

The following example will discuss the influence of the load-dependent center distance on the meshing of a dual-clutch gearbox. Figure 1 shows the cross-section of the 3D gear model in the FVA-Workbench gear design software. The gearbox consists of the double clutch at the gearbox input, which engages either the hollow shaft for the odd gears or the solid shaft for the even gears. Idler gears are mounted on the countershaft. The power is transmitted out of the gearbox via a bevel gear stage.

Since the greatest deflection is to be expected in the center of the countershaft, the second gear is considered the critical gear and is discussed in the example below. The gearing

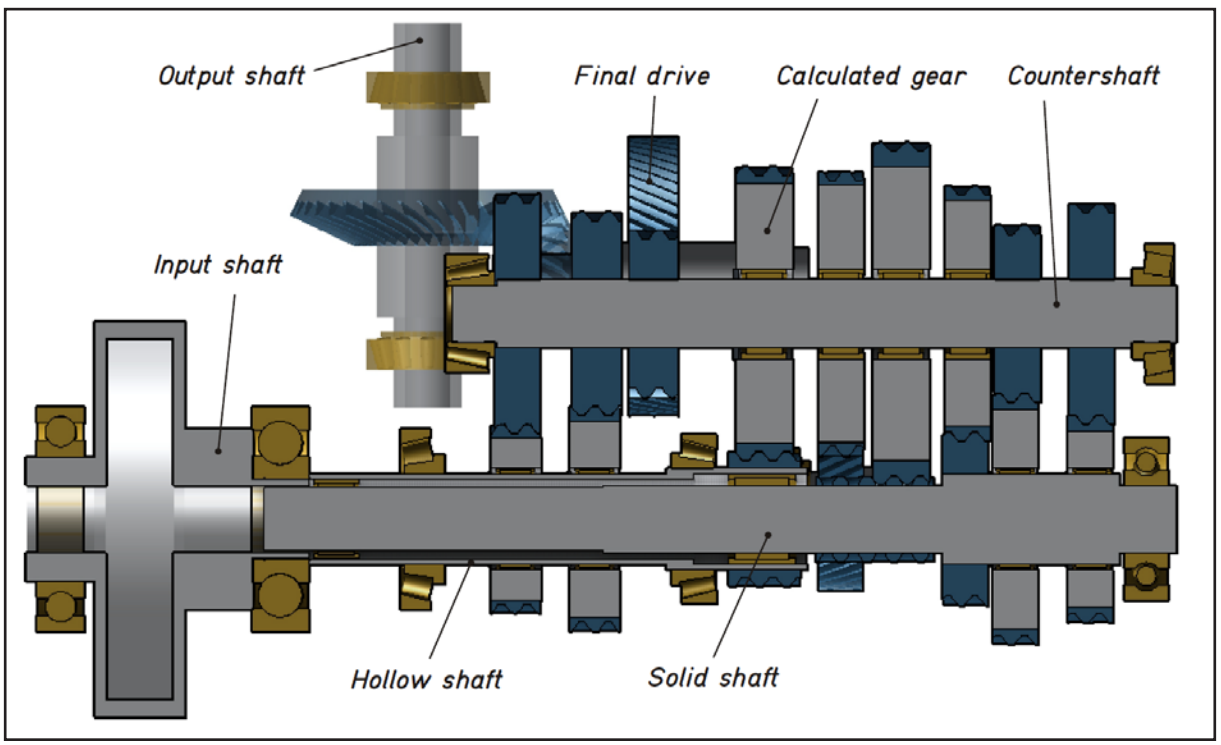
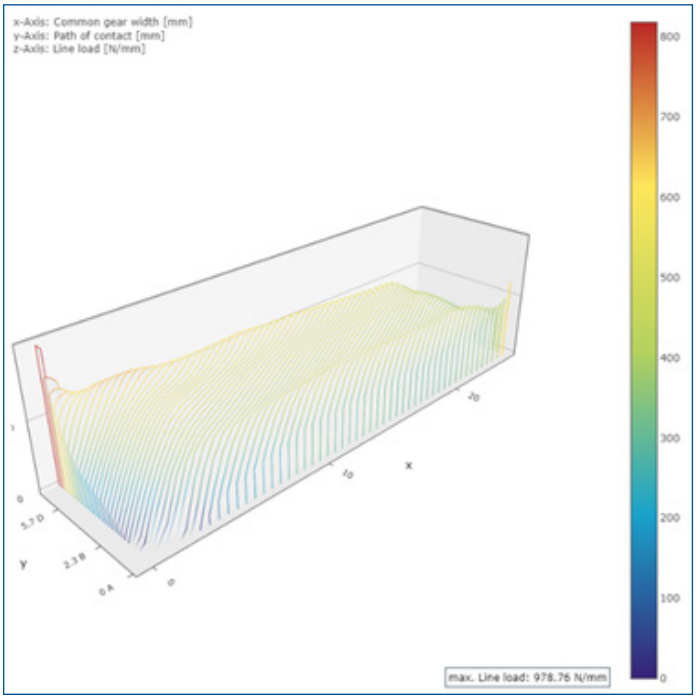


Figure 1 Simulated cross-section of a dual-clutch gearbox in the FVA-Workbench.

Table 1 Gear safety factors with and without the load-dependent center distance					
		With load-dependent center distance		Without load-dependent center distance	
		Pinion	Wheel	Pinion	Wheel
Flank safety factor	SH	0.68	0.68	0.72	0.72
Root safety factor	SF	0.94	0.78	0.52	0.52

Load distribution with load-dependent center distance



Load distribution without load-dependent center distance

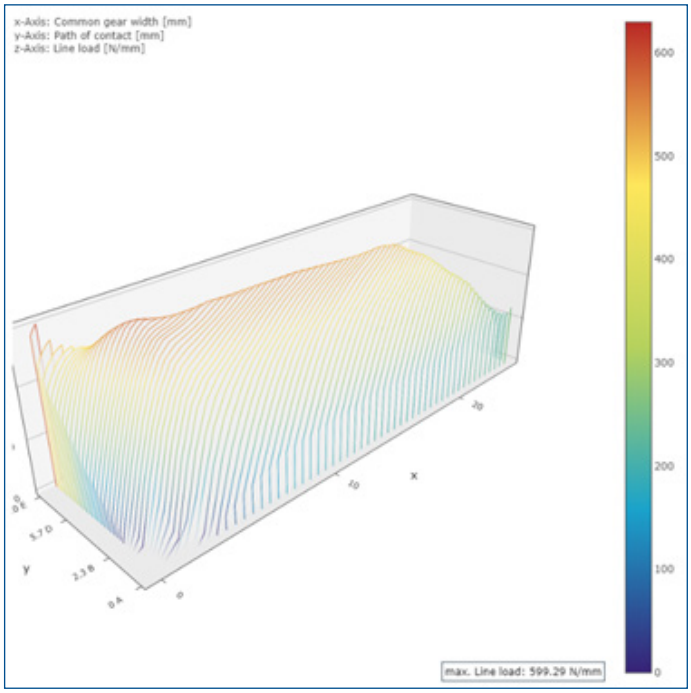


Figure 2 Representation of the load distribution with and without the load-dependent center distance from an FVA-Workbench output report.

is designed so that the pressure is as uniform as possible and does not exceed a maximum value of 1500 MPa. The applied modification ensures that no load or pressure peaks are to be expected on the flank.

Influence on the load carrying capacity

The contact ratio determines many key characteristics of the gearing. It indicates the average number of teeth across which the load is distributed. A contact ratio of 1 indicates that exactly one pair of teeth is always in mesh, while a contact ratio of 1.5 indicates that 2 pairs of teeth are in mesh across half of the path of contact. The meshing forces can thus be distributed across multiple teeth, which is beneficial for the load carrying capacity.

Due to the flexible design of the countershaft, the meshing forces push the teeth away from each other, which reduces the contact ratio. The average number of teeth transmitting the load is reduced correspondingly. This has a negative effect on the safety factors. In this example, the design criteria were defined exclusively by the pressure, and the safety factors according to ISO 6336 (without consideration of a load spectrum) are correspondingly low.

Table 1 shows that the flank safety factor is slightly reduced by taking the load-dependent center distance into account. However, the root safety factor increases significantly. This is due to the fact that the lever arm for the meshing force is increased, so that the load is smaller. However, the bending moment arm on the tooth increases, as the overall load is higher. In this case, the load-dependent center distance has a positive effect, but there can also be cases in which the tooth root safety is reduced. Thus, it is essential to take the load-dependent center distance into account.

Influence on the load and pressure distribution

The microgeometry of the gear plays a key role in the load and pressure distribution. Figure 2 clearly shows that the gear was designed without taking the influence of the load-dependent center distance into account. If this influence is considered, the load distribution in the direction of the mesh is no longer uniform, but increases significantly.

Figure 3 shows a simulation of the pressure distribution from an FVA-Workbench results report. Excess pressure can be seen at both the beginning and end of the mesh due to insufficient tip and root relief.

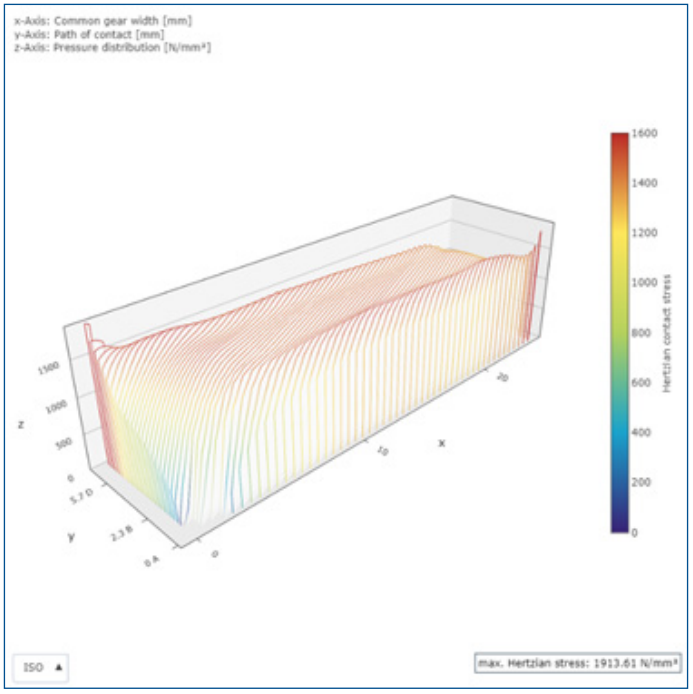
Influence on the noise excitation

One evaluation criterion for the noise excitation is the transmission error and excitation level. Transmission error occurs as a result of fluctuating stiffnesses in the gear and different loads, depending on the mesh position. The excitation level is formed from a weighted sum of the individual frequencies of the gear, with an emphasis on the audible frequencies. This is described in FVA 133 — Overlap ratio, FZG — TU München.

The influence of the load-dependent center distance becomes even clearer if the transmission error is calculated from the represented load distribution. The range of variation of the transmission error increases by more than 50%, while the excitation range increases from 16.79 dB to 19.35 dB. It can therefore be assumed that this gearbox is significantly louder than one in which the load-dependent center distance is considered in the design.

Figure 4 shows a simulation of the transmission error with

Pressure distribution with load-dependent center distance



Pressure distribution without load-dependent center distance

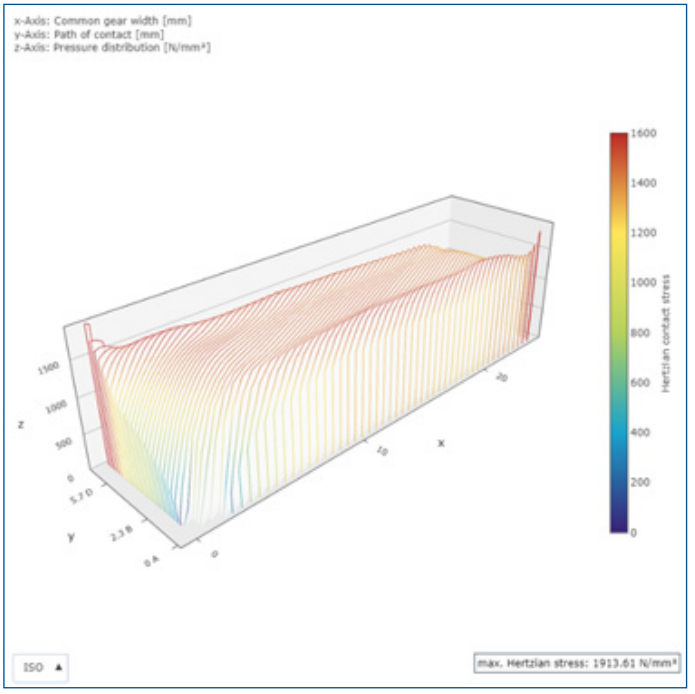
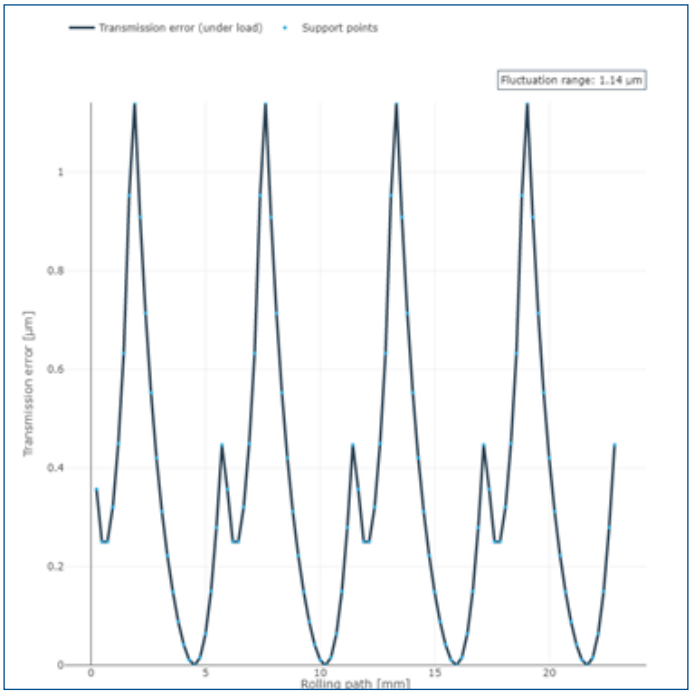


Figure 3 Representation of the pressure distribution with and without the load-dependent center distance from an FVA-Workbench output report.



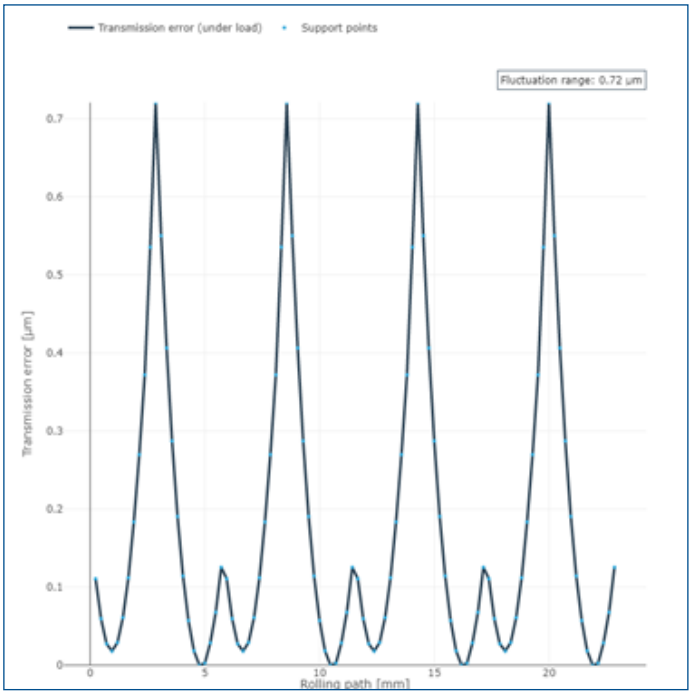


Figure 4 Representation of the transmission error with and without the load-dependent center distance from an FVA-Workbench results report.

and without the load-dependent center distance from an FVA-Workbench results report.

Influence on the tooth root stress

FVA 264 offers a method for further consideration of the tooth root stress, in which the local tooth root stress over the mesh can be solved using the BEM method. Figure 5 shows a simulation of the tooth root stress with and without the load-dependent center distance from an FVA-Workbench results report.

Analysis shows that the tooth root stress on the wheel increases from 739 N/mm² to 826 N/mm² when the load-dependent center distance is taken into account. At the same time, the stress on the pinion decreases slightly from 809 N/mm² to 788 N/mm².

Consideration of the load-dependent center distance in the FVA-Workbench

This example features a particularly soft design. As a result, the influence of the load-dependent center distance is very prominent. In particular, a significant increase in the tooth root safety can be observed. However, this is not a general trend; it only applies to this example. Therefore, consideration of the load-dependent center distance is always recommended.

Considering the local flank parameters, such as pressure or transmission error, a significant influence of the load-dependent center distance can be observed. Pressure increases of around 400 N/mm² can be seen at the transition between the tip relief and the flank. This shows that the influence of the load-dependent center distance must be taken into account when designing modifications. The noise excitation of the gearbox can be evaluated from the transmission error.

The more than 50% increase in the transmission error underscores the necessity of accounting for the load-dependent center distance. In this case, it becomes clear that the applied modification is no longer adequate. With the FVA-Workbench, the load-dependent center distance is always considered. **PTE**

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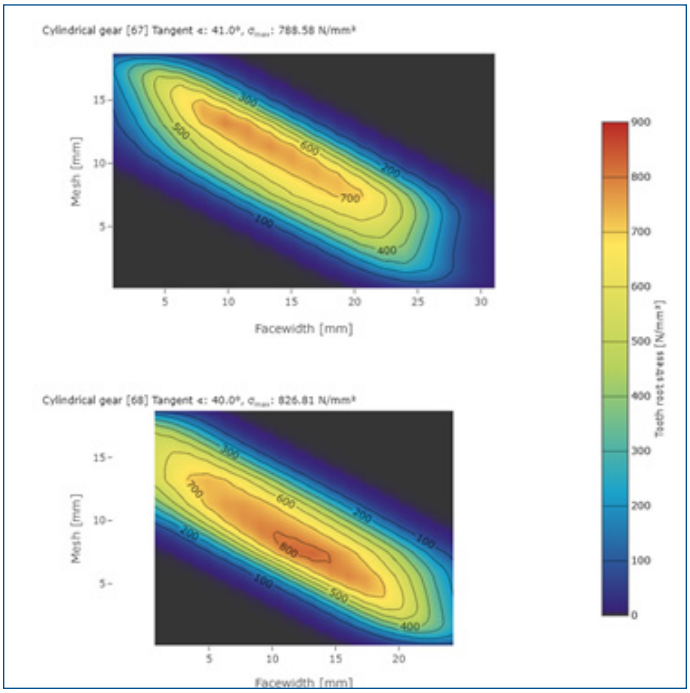
Transmission error with load-dependent center distance



Transmission error without load-dependent center distance

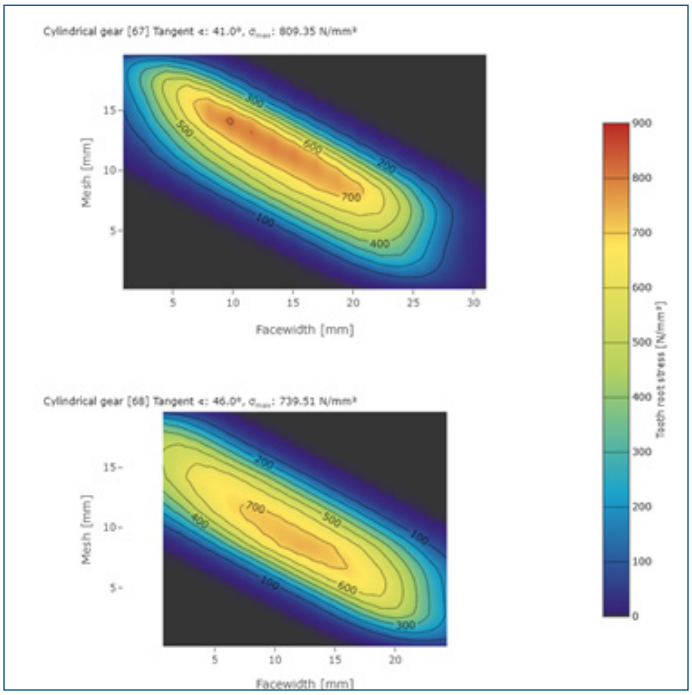


Figure 5 Simulation of the different tooth root stress with and without the load-dependent center distance from an FVA-Workbench results report. The pinion is shown in each image.

Stay "On-Track" When Selecting a Linear Guide System

Dave Arguin

Linear Guide Systems are perhaps the most diverse group of products in the motion control industry. Available in numerous configurations with widely varying performance characteristics, selecting the right linear guide system for your application can be challenging. One of the essential characteristics to consider is guide rail performance -- primarily based on speed, load-carrying capacity, and moment load limitations. Load limits for linear guide systems depend on the orientation of the slide and the position of the mass being moved. Therefore, carefully consider whether the system will consist of a single axis, or will require multiple axes, such as in a stage or gantry system.

Space constraints can be another determining factor in the selection process. For example, base size, cross-section, and stroke length ratio compared to the overall length of the system will help narrow down the appropriate choices. Other characteristics to consider in system selection are cost, smoothness of operation, noise, and preference or familiarity of the guide rail system to the designer.

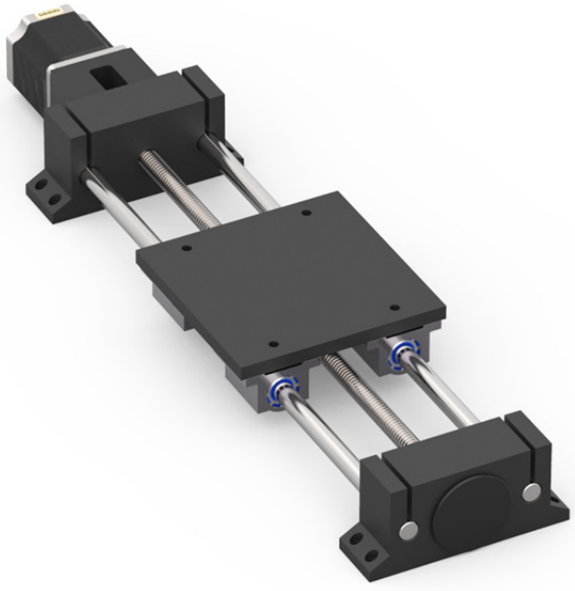


Figure 1 Helix Linear 212 series linear guide system shown with round shaft guide rails.

Types of Linear Guide Systems

Round Rails

Linear guide systems utilizing round rails feature ball bushings or sliding bushings options. They can be free-spanning or fully supported on an I-beam structure. Round shafting offers low to moderate load-carrying capability as a result of rail deflection. The load limit is highly dependent on the rail length as the rails are designed to be supported on each end. The longer the rail, the greater the potential deflection when radially loading the guides.

When using the round rails, larger diameter rails can provide higher load limits when needed. However, bushings with a larger outer diameter are also required, often leading to space constraints. Round guide rails are ideal for applications with a vertical orientation where the load does not impact the rail because there is little or no side load on the shaft. In addition, recirculating ball bushings provide low friction for smooth operation along the travel length.

A round rail bushing may be less design-friendly based on the round outside diameter and means of finding a way to capture it in the actual assembly. The height and overall position of both ends of the round shaft should be designed to line up, ensuring overall system alignment. Properly designed end mounts help make this alignment easier.

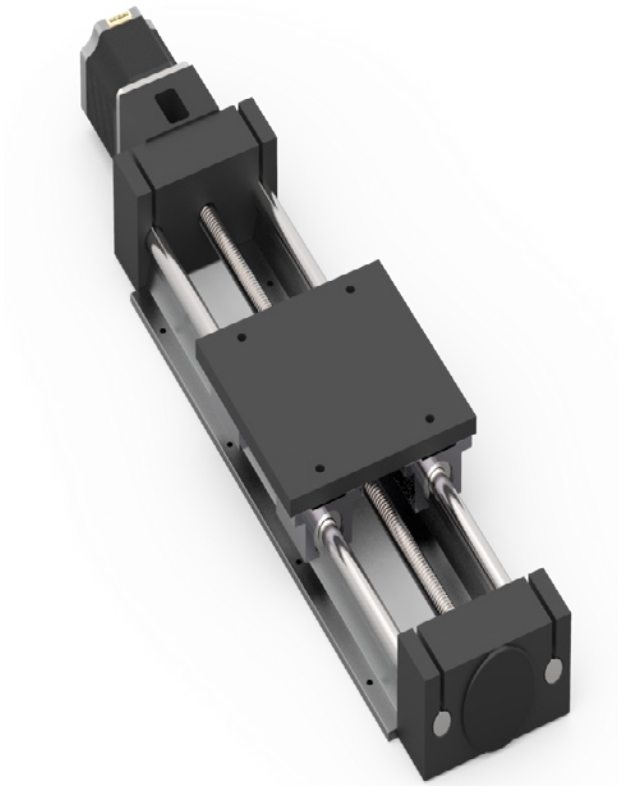


Figure 2 Helix Linear 252 Series linear guide system shown with fully supported round shaft guide rails.

As an alternative, round shafting can be mounted on a structure that fully supports the guide rail and removes deflection concerns. In many cases, a smaller diameter rail can be used as a result. The rails are mounted to I-beam support

where the base has mounting feet to secure the linear guide system along the entire length of travel. This configuration supports the movement of heavy loads and is ideal in industrial applications.

Round rail linear guide systems are also available with plastic guide bushings. These low friction sliding bearings, usually combined with PTFE additives, are lower in cost and generally smaller than recirculating ball bushings. Though they can provide higher design flexibility due to reduced size, plastic guide bushings are designed for use in applications with light loads.

Although considered low friction, the friction drag is higher in linear guide systems with round rails and plastic guide bushings. The system motor should be adequately sized to account for the higher torque required to move the carriage. The downfall to this type of friction bearing is that it doesn't support overhung or moment loads well. As a result, the friction increases significantly, and binding can occur. In addition, the stiffness of the system is greatly reduced due to clearances in the bushing and material deflection. Though they have limitations, plastic slide bushings are ideal for dusty, dirty environments and may eliminate the need for a bellows or cover to protect the rails.

Profile Rails

Profile Rails (often referred to as square rails) provide low-friction, smooth guiding systems with high accuracy and stiffness. The square rail design provides support for loads where the center of gravity is directly above the guide rails and also provides the ability to handle moment loads. Square profile rails use recirculating balls in runner blocks called carts, trucks, or carriages that the payload attaches to.

Square profile rails can be mounted both vertically or horizontally. When mounting horizontally, consideration should be given to whether the linear guide system will be mounted flat with the load resting on top of the runner blocks, on its side, or hung upside down. For moment loads, profile rail assemblies are rated differently in yaw, pitch, and roll directions. Therefore, care must be taken not to exceed the load limit based on the mounting position.

If the load is exceeded, utilization of two runner blocks per guide rail can be a solution. However, it may reduce the stroke length or require a longer overall length to achieve the stroke needed. If space constraints are a factor, profile rails can be designed with longer runner blocks to handle higher moment loads. Many profile rail guide systems also have wider rail and wider runner block options available.

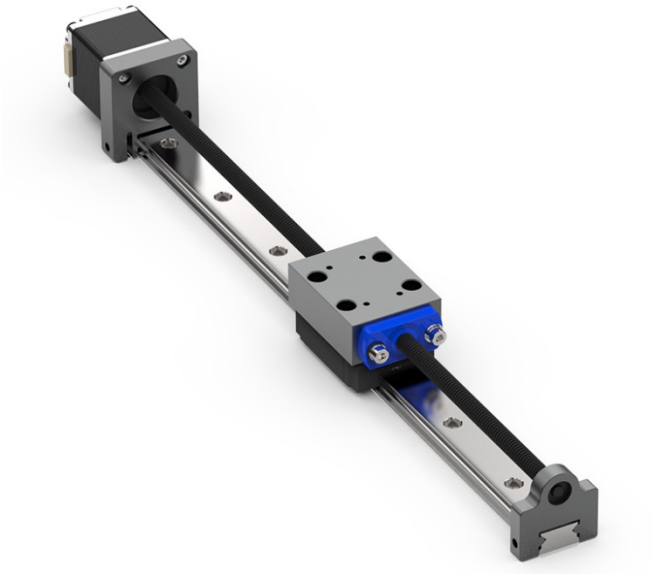


Figure 3 Helix Linear Guide System with single profile rail.

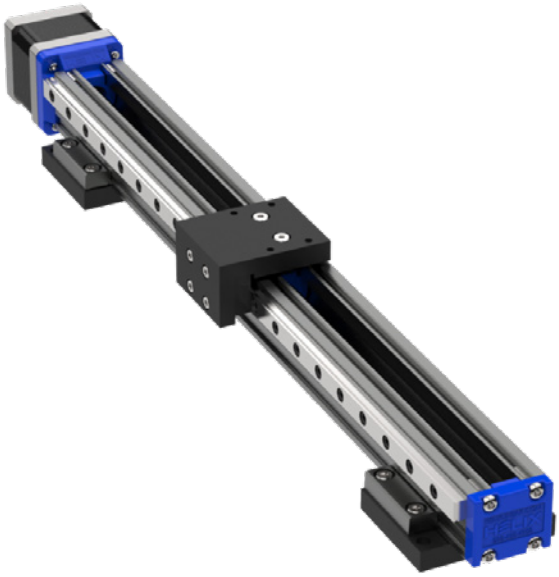


Figure 4 Helix Linear miniature precision actuator with dual profile rail guides.

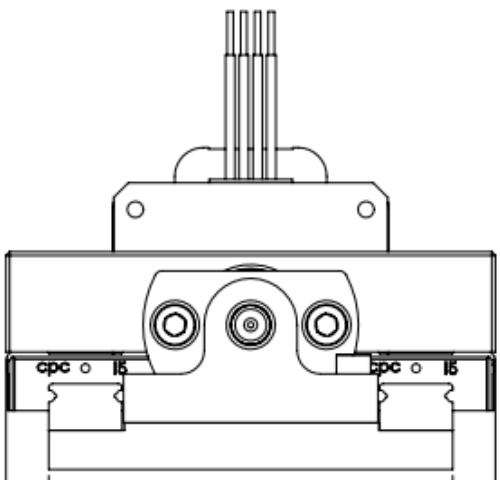


Figure 5 Helix Linear guide system with dual profile rail guides.

Profile Rails have more design versatility for mounting due to the flat-mount surface of the runner blocks and tapped holes that secure the base or mating component that is being moved. In addition, profile rails are relatively simple to align when the mating part has a slightly raised milled or ground shoulder to use as a registration edge or datum. The edge of the profile rail can be pushed up against the shoulder during assembly to ensure proper alignment.

Roller Slides

Roller slides provide a very economical means for linear system guidance, generally constructed of lightweight aluminum with four rollers inside the carriage that run on hardened shafts. Roller Slides are suitable in applications requiring high speeds with large on-axis loads and moment loads. In addition to providing a stable and accurate means for linear motion and a low design profile, they are also a low-noise solution vs. their recirculating ball counterparts.

Figure 6 Helix Linear Technologies roller slide linear guide systems.

Cross-roller Slides

Cross-roller linear guide systems have cylindrical rollers in v-groove races (instead of recirculating balls). The roller bearings have an alternating 90-degree pattern to support the load. The cost is higher than other guide rails but comes with added benefits. Cross-roller guide rails provide superior stiffness and stability with low noise and smooth operation. They are specifically designed for applications requiring very high loads and moment loads.

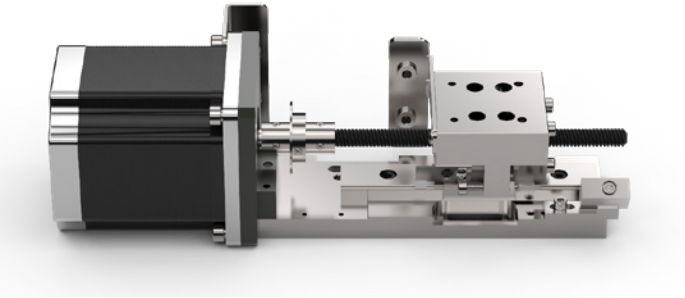


Figure 7 Helix Linear custom linear guide system with cross-roller bearing.

Extrusion Guides

One of the most economical ways to create a linear guide system is through extrusions. Built-in characteristics can function as guides and anti-rotation features with the assembly itself. Generally, these are friction slides that run on a track inherent in the shape, either internally or externally. Design simplicity makes extrusion guides beneficial in applications with limited amounts of space. While the accuracy and stiffness of extrusion guides may not be as high as other available choices, it can be an ideal solution when other guide rails are overkill for the technical requirements.

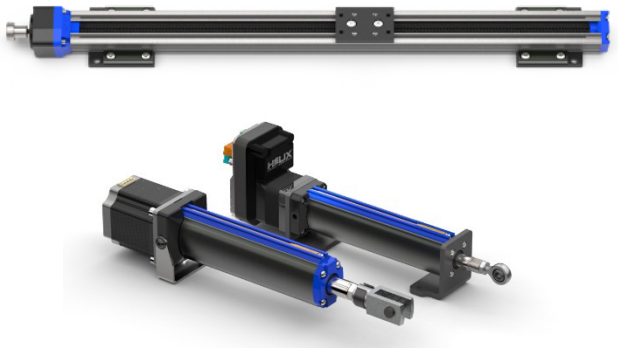


Figure 8 Helix Linear electric cylinder product (left) and MPA linear guide system with PTFE slide on extrusion.

How to Choose the Best Linear Guide System?

There is certainly overlap in both cost and performance characteristics of the linear guide systems offered. In these cases, the ability to customize the system for OEM designs can help define which option to choose as the foundation for your project. Environmental concerns can also be a deciding factor. Consider requirements such as dust/dirt vs. cleanroom compliant options, high or low-temperature requirements, and if industrial strength or food-grade materials are necessary. These conditions will significantly impact the system design and influence decisions such as using lead screws vs.

ball screws, whether incorporated materials need specific chemical resistivity, or low outgassing properties.

Choosing a linear guide system supplier should also factor into your system design decision. For example, some manufacturing partners provide high-level assembly capabilities and offer testing services before shipping. As a result, they provide a turnkey solution that works right out of the box, helping you reduce assembly time, eliminate alignment issues, and save valuable time and money.

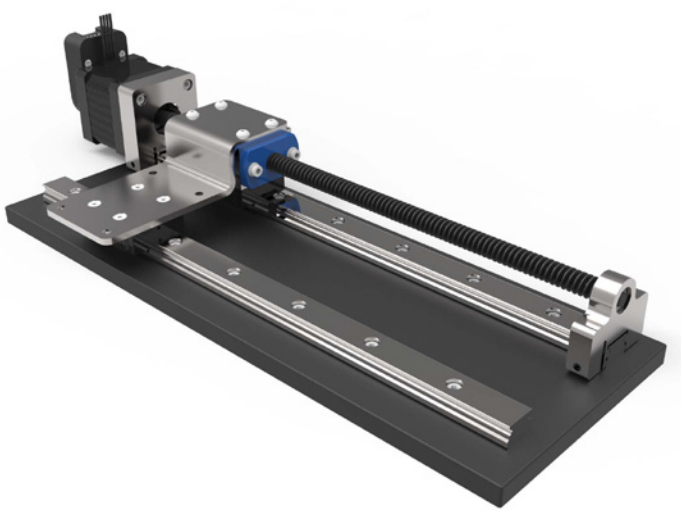


Figure 9 Dual profile rail linear guide system.

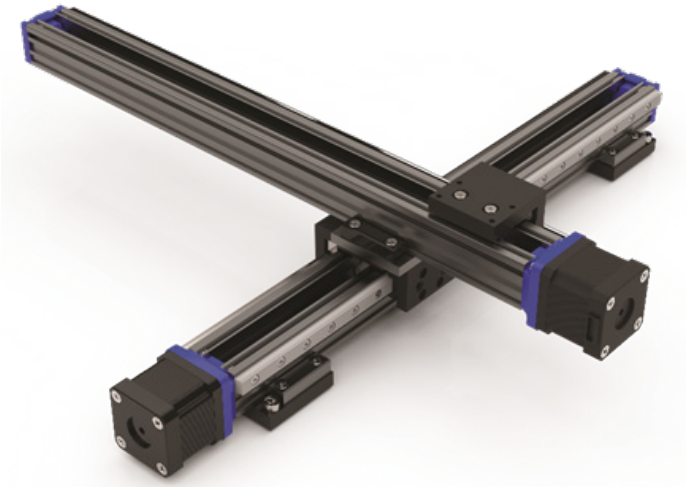


Figure 10 Helix Linear custom multi-axis linear guide System with profile rails and extrusions.

The chart below helps summarize each type of linear guide system and ranks and compares multiple selection attributes. System designers should also consult with the manufacturer's application engineering team to assist in making optimized selections based on your specific application requirements.

For additional assistance with linear guide system design and selection, please visit *HexlixLinear.com*. **PTE**

Features	Round Rail *with* Recirculating Balls	Round Rail *with* Sliding Bushing	Round Rail Fully Supported	Profile Rail (Square Rail)	Roller Slides	Cross Roller Slides	Extrusion Guides
Load Capacity (Radial)	medium	low	medium-high	high	high	high	low
Accuracy	medium	low	medium	medium-high	medium	high	low
Cost	low	very low	medium	low-medium	low-medium	medium-high	low
Load Capacity (Moment)	medium	low	low	medium	high	very-high	low
Noise	medium	low	low	medium	high	very-high	low
Smoothness	high	medium	high	medium	high	high	low-medium
Speed	medium	low-medium	medium	medium	high	high	low-medium
Available Preloaded	no	yes	no	yes	yes	yes	yes
End Support Mounted	yes	yes	no	no	no	no	no
Drag	low	medium	low	low-medium	low	low	medium

Dave Arguin, President of Helix Linear Technologies, has over 28 years of linear motion expertise. His initiatives in product innovation, manufacturing excellence, and engineered solutions help Helix Linear Technologies' customers achieve the most significant outputs in their linear motion projects.

www.helixlinear.com

Open Loop Step Motor Error Sources — What Closing the Loop Corrects

Donald Labriola P.E.

Two-Phase Hybrid Step Motors — also known as transverse magnetic flux permanent magnet motors — provide a very cost-effective and simple motion control solution. However, they have a number of inherent errors when operated open-loop or quasi-open loop (which some manufacturers call closed loop). We will go through several of the dominant error sources when using these motors, and comment on how the errors are overcome by true servo operation of these motors.

Previous articles have highlighted the difference in the laminate design that determines whether the motor is optimized for microstep operation or for full step operation. In this article we will focus on the microstep optimized laminate hybrid step motors.

Degrees of Servo – None to Full

First a quick definition of the terms we will use to describe closed loop "levels." This was covered in detail in a previous article, so I will keep this section brief. The basic step motor is considered open loop — there is no feedback of position. The first level of closing the motor uses a typically lower resolution encoder to adjust the stepping rate so as to keep the motor error to usually no more than either plus-or-minus 1 full step or 1.5 full steps (according to the patent). This helps the motor provide high torque without loss of steps, but it does address the resonance problems (see below); I refer to this as quasi-closed loop.

Another level of closed loop observes the motor current versus applied voltages to estimate the rotor position using Kalman estimator techniques (or similar). These indirectly are measuring the back-EMF of the motor to determine position by measuring how the back-EMF affects the measured current. They are effective at higher speeds where there is sufficient back-EMF, but they typically revert to open loop step operation below some minimum speed, and are not able to correct position errors below the minimum speed. Then you have full servo, which measures the rotor position and can control the motion from zero speed to the full motor speed.

Motor-Related Errors

Even within the microstep laminate variety of motors, there are still different optimizations for trading off detent torque versus maximum holding torque. For high accuracy, the detent torque needs to be minimized to reduce the magnitude of the error it introduces, and the harmonic content of the detent torque also needs to be minimized to help prevent "snapping" from one pole to the next pole. If the detent torque has significant harmonics, the rapid change in detent torque versus angle will cause vibrations and stopped position errors as the motor goes over these "speed bumps." An earlier article provided techniques for measuring harmonic content of the detent torque.

In addition to the errors introduced by design choices such as detent torque and harmonic content, there are also manufacturing tolerances. These include the shape of the tooth as actually produced by the die, distortions in the laminate metal produced by the stamping process (which affect the grain structure and thus the magnetic properties of the steel adjacent to the cut), and the balancing of the anisotropic nature of the rolled steel used for the laminates (grain direction affects the magnetic properties). Finally, the degree of the centering of the rotor within the stator and of the rotor about its bearings affects accuracy of the motion.

Looking at a series of the specifications provided by multiple step motor manufacturers — and not all provide accuracy specifications — the specifications are called out as ±3% to ±6% non-cumulative error by different vendors; others call out a step to step error of .09 degrees for a 1.8 degree step motor (±5% of a step). This is the best expected open loop accuracy for the no-load condition at the full step location, which hides the effect of detent torque. Thus even with perfect microstepping current control, the expected error from the unloaded motor is not better than $1/20^{th}$ of a step. And real position error only gets worse as we start adding any load and friction to the motor!

Driver-Related Errors

The motor manufactures typically specify resistance as ±10% at room temperature, with inductance typically specified to ±20%. A good current mode driver should compensate for most of these differences, at least for the full step locations. Many recirculating drives have problems controlling the current near zero current due to cross over distortion. Two issues that contribute to this error: dead-band and minimum duty cycle. Dead-band arises from the minimum allowed time between turning off the upper transistor stage and turning on the lower stage (or Vise-versa) that is allowed so as to prevent shoot-through current (current which flows through both high-side and low-side transistors — which generates much EMI and can destroy the driver). On a PWM controlled stage, the dead-band reduces the effective PWM signal so that the overall current is reduced towards zero. This reduces both the peak expected current (which can be easily corrected with a PI current controller) and the current near the cross over (which is not as easily corrected if the commutation rate is faster than the PI loop). The dead-band shown corresponds to 200nS of dead time with a 25kHz chopping rate for a 2.5v motor running from a 48v supply. This level of error represents 0.16 degrees or about 1/8 of a step (Figure 2). QuickSilver compensates for dead-band, which significantly reduces the position offset when operating in

open loop, and smooths the resulting motion when operating in closed loop.

Another significant distortion inducing limitation is the minimum allowable on-time for the driver. The transistors take a finite time to fully turn on before they are switched off again. The minimum on-time can be on the order of 1uS for some common drivers. For a 25kHz chopping rate (40uS per cycle), this is 2.5% on minimum. With a 48v power supply used with a 4 amp 23 frame motor — typically having a .5 ohm winding resistance, the minimum on time produces 1us/40us*48v = 1.4v to the winding. With a .5 ohm winding this corresponds to 2.8A. To reduce the current to a lower level, the chopper drive must either drop out of recirculate mode (which makes the average current much less than the peak sensing used in the control loop and increases the ripple current), or it must increase the time between pulses which allows the chopping frequency to enter the audible frequency range causing an audible squeal. The large minimum current also causes a significant step in position as the current reverses as the current jumps from the minimum positive current to the minimum negative current when using a typical current sensing recirculate scheme. QuickSilver addresses this by using a gated anti-phase technique in which a controlled reverse pulse period is used with the main forward pulse to allow a smooth transition from positive to negative current while keeping the motor drive active (avoiding decay mode and its large ripple currents). The gated anti-phase technique also allows for excellent control of the current in all four quadrants of operation — that is both when using the motor to accelerate the load (supplying power — 1st and 3rd quadrant) and when using the motor to decelerate the load (absorbing power — 2nd and 4th quadrant). Typical peak current sensing recirculating drivers are not as

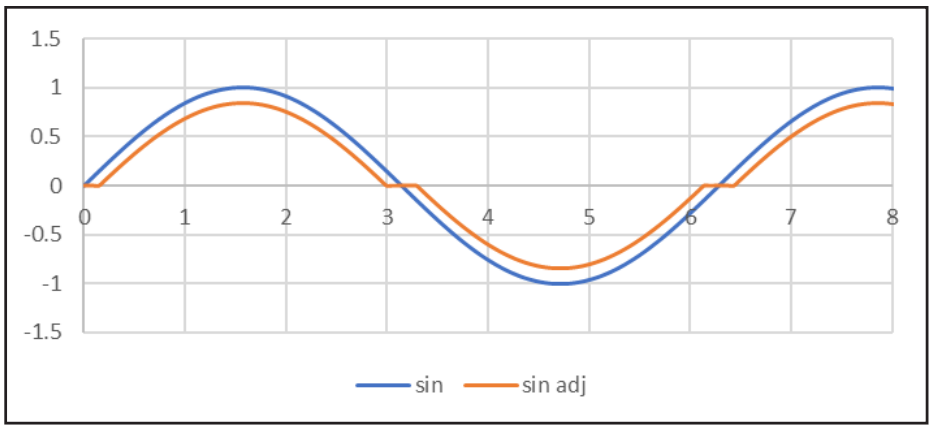


Figure 1 Deadband

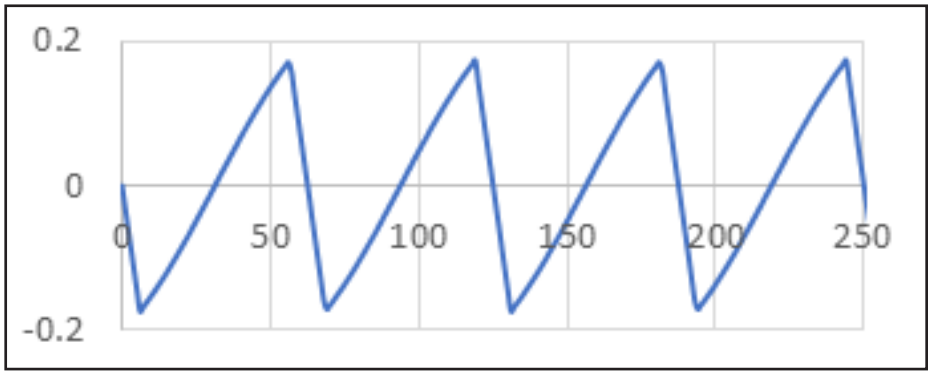


Figure 2 Dead-band Error in degrees

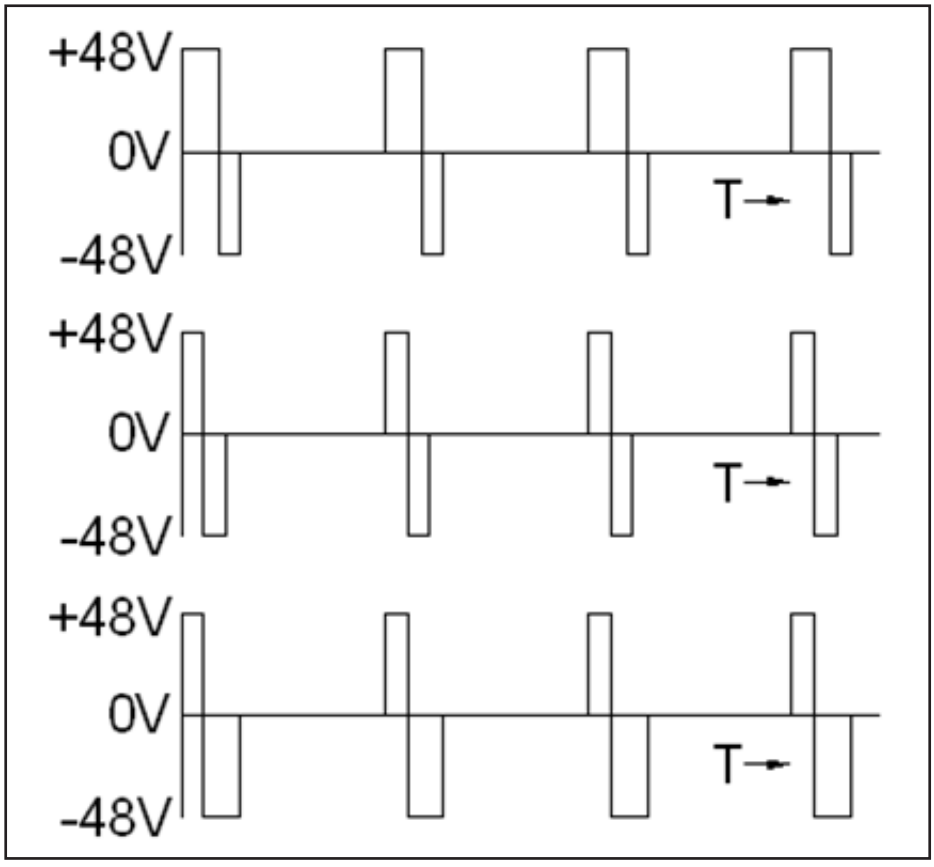


Figure 3 Gated Anti-Phase

accurate in the 2nd and 4th quadrants controlling the current while decelerating the motor.

Additional Motor Variances

Additional motor manufacturing variances that can affect microstep accuracy include the balance of A and B windings. If the rotor is not centered on the stator, the average gap between the rotor to the stator associated with each phase may not be balanced. This imbalance may cause the back-EMF of phase A to vary substantially from that of phase B. The back-EMF of the motor directly relates to the torque constant (Newton meters per amp) of the motor, so this affects both the pointing accuracy and the smoothness of rotation of the motor. Closely related is the quadrature of the two phases, which can also be affected by rotor to stator alignment. Normally, the back-EMF of the two phases are offset by 90 electrical degrees so that the optimal waveforms are sine and cosine currents. If the rotor alignment is not well centered, this angle between the phases can vary, causing the motor angle to not be accurate, and the torque generated to vary as a function of motor position. The balance and quadrature are errors are usually fairly low, but rough handling of a step motor can significantly impact these by misaligning the rotor centering to the stator. Closed loop operation can significantly compensate for the motor imperfections to obtain smoother and more accurate motions.

Hysteresis

One effect that remains in open loop operated motors is magnetic hysteresis. The magnetic field from the stator does not drop to zero when the current drops to zero, but rather the stator remains partially magnetized. When the current is applied in the opposite direction with sufficient magnitude to reverse the hysteresis, the motor will take a larger (micro) step. This shows up as a larger motion as the motor passes through the full step locations as these locations correspond to where one of the two phases crosses through zero current. QuickSilver driver techniques also combat the hysteresis effects to smooth the motion both when operating open loop and closed loop.

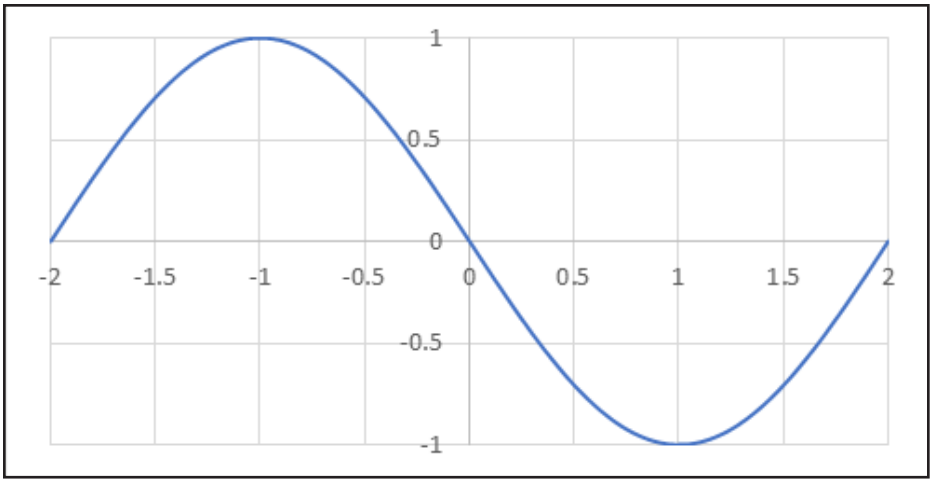


Figure 4 Norm Torque vs. Error steps

Torque Generation

The step motor only generates torque when there is a an error angle present. Zero error (difference between the magnetic angle presented to the motor via the two motor phase currents and the mechanical angle of the shaft). The electrical cycle repeats every 4 full steps (7.2 mechanical degrees for a 1.8 degree stepper). If the rotor is slightly ahead of the magnetic angle, then a negative torque is generated (Figure 4 shows normalized torque versus error angle in steps). A negative error angle produces a positive torque - as long as the error is less than 2 steps. The maximum torque generated is at one full step error and going beyond plus or minus 1 full step of error and the torque starts falling. Going past 2 full steps and the torque pushes the rotor further away until it comes to a rest again at 4 full steps (or a multiple of 4 full steps) from the targeted position. This is how open loop step motors loose steps.

Of note is that a load requiring 50% of the motor torque forces an error of 30 electrical degrees or 1/3 of a full step. Friction is only overcome if the error angle is sufficient to generate torque sufficient to exceed the friction magnitude. Any ringing may end up on either side of the zero point according to which side of the ringing waveform ended up with just enough friction to "capture" the rotor and stop motion. So micro-step drives, even if there are many fine divisions very accurately controlled, still may have significant following and stopping error due to load forces and friction.

True servo closed loop systems measure the error and apply appropriate current at the needed angle to move the rotor to the desired position. Quasi-closed loop steppers only prevent losing multiple steps, but otherwise still have the problems with load and friction induced errors.

Resonances

Low frequency resonance arises from the torque curve of the motor (which approximates a K-theta rotary spring) interacting with the rotary inertia of the motor (and the load). This sets up a rotary pendulum. When the stepping frequency of the motor excites the resonance of this pendulum, it causes an oscillation to grow. At some frequencies, the motor ends up moving in the wrong direction as the next step is applied, resulting in 90% or more loss in available torque and very rough motion. Lost steps or total loss of synchronization may happen if the load torque exceeds the available torque. It is also possible to excide other modes where the motor operates at a fraction or a multiple of the drive frequency due to the non-linear torque curve causing non-linear mixing of the applied sine wave with the back-EMF of the motor. You may get motion but at the wrong speed or the wrong direction!

The low frequency resonance issues

are still present with quasi-closed loop (error limiting systems), except that they will not lose steps. True closed loop system keep the motor phase angle at either +1 step or -1 step and vary the current magnitude to get the required torque. By keeping the motor at the peak of the torque curve, the motor efficiency is maximized, while also making the derivative of torque with respect to angle zero. The system is no longer a 2nd order oscillatory system, but rather a damped first order system: the motor runs cooler and smoother!

Mid-frequency resonance is not a true resonance, but rather a limit cycle oscillation. When using a peak current controlling recirculating drive, there is a critical frequency where there is not quite enough on time for the controller to bring the current to the desired level in the provided time. The back-EMF of the motor and the motor inductance resist the rate of current change needed. At this speed, the drive is no longer able to reach the full current, and so the drive switches from acting like a current controlled drive with a low phase lag to being a voltage driving the inductance of the motor with a 90 degree electrical lag. The reduced drive angle causes the motor to slow down slightly, which then allows the current control to engage, only to speed up and no longer reach full current. The resulting instability due to alternating between a current control and voltage control causes a speed oscillation that appears to be a resonance. Closed loop control of the motor current using a knowledge of this issue is able to suppress this limit cycle allowing for a wide range of speeds with full available torque and significantly smoother motions.

High Inertias Interacting with Low Damping Current Drives

Dynamic errors can be very problematic with high inertia loads. Even with careful ramp generation to attempt to minimize the ringing, a load can oscillate about the commanded trajectory by ±½ step over the duration of even an extended move. For example, this type of oscillation has been noted to continue almost unabated over a 16 second spin of a high inertial load. The oscillation remained over the full spin time and likely would have continued if the duration of the spin had been longer. This continued oscillation is due to the very low damping associated with a current mode driver interacting with a step motor.

Additional errors can occur if the motor is operated near resonant frequencies of the motor. Avoiding resonance involves trying to jump through the problematic resonance frequencies to keep from building up oscillations, but that may not be the motion needed for the apparatus!

Many microstep controllers also have a problem at higher speeds as they cannot update the requested phase fast enough to hit all 256 micro-steps of a high-resolution microstep controller. They end up having to change modes at different speeds which can give rise to torque hiccups at these transitions. The chopping rate may also not allow the driver to actually hit the intervening micro-steps as the chopper drive may not be in the drive mode for several of the intervals when chopping at a nominal 25kHz to avoid excess heating.

QuickSilver adds significant damping to the system both in the driver algorithms which can modify the electrical impedance seen by the motor and by adding damping terms to approximate a viscous inertial damper to the control system law. We also use a fixed sampling system to handle the commutation without jumping modes like the micro-step controllers require.

The inherent damping of a step motor with a low impedance drive can be easily seen by shorting the leads of the step motor and attempting to rotate the shaft. A true current mode driver has a very high impedance which can impart torque, but does not interact significantly with the motor back-EMF. A controlled impedance drive algorithm can provide good 4 quadrant performance, high efficiency, and significant damping to allow for very smooth operations even with a widely varying load.

The ultimate performance of these motor varies greatly with the drive and control algorithms and circuits. Motor efficiency, acoustical noise, vibration, damping and available torque-speed curves can all be significantly improved by the appropriate algorithms! **PTE**

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

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Fenner Acquires Lumsden Corporation

ADVANCES AND EXPANDS BELTING AND HIGH-VALUE COMPONENT SOLUTIONS

MATTHEW JASTER, SENIOR EDITOR

Fenner Precision Polymers recently announced the acquisition of Lumsden Corporation, a leading manufacturer of industrial conveyor belting as well as related solutions for a wide variety of applications including food processing, heat treating, mining, glass treating, printing and canning.

The opportunity for collaboration began back in 2013 when Jack Krecek, divisional managing director, Fenner Precision Polymers met Glenn Farrell, CEO, Lumsden Corporation at a Lancaster Chamber of Commerce dinner and the two quickly realized their respected companies had similar interests.

"Our companies shared sales reps, customers, etc., and we developed a peer/mentorship relationship through the years. It became stronger during COVID as we navigated similar threats and challenges to our businesses," Krecek said.

"We sell through independent sales reps throughout North America and when we started talking about acquisitions as an opportunity for growth — Lumsden Corporation came up again and again in conversation," said Brian Slingluff, vice president and general manager, Fenner Precision Polymers -US. "We approached Lumsden with the idea that there was some synergy and a similar approach to the marketplace. It seemed like a perfect fit."

A Shared History

Manheim Manufacturing and Belting Company started in 1911 (Manheim, Pennsylvania) by three area businessmen as a manufacturer of conveyor belting for agricultural markets.

The company's Balata natural rubber conveyor belting soon developed a strong regional reputation, leading Manheim to supply flat power transmission belts to general industry. These power transmission belts were used by various railroads to drive the generators of electrified rail cars. The company was purchased by Fenner in 1984.

Lumsden Belting has been manufacturing metal conveyor belts in Lancaster, Pennsylvania for 45+ years. Founder Alexander D. Lumsden put an emphasis on quality, customer service and innovation for areas like food and beverage, industrial products and electronics. At one point Hoyt Wire Cloth (Lumsden Corporation) was part of a local conglomerate that included Manheim Belting and a few other companies.

"So, there was a period there where both companies had similar ownership for a number of years in Pennsylvania," Slingluff said.

Lumsden brands include Wiremation Conveyor Belting and Flexx Flow while their other side of the business is the Hoyt Wire Cloth brand. Hoyt Wire Cloth is largely used in crushed stone, sand and gravel, concrete and asphalt, coal, and recycling applications. Wiremation is focused on food processing, heat treating, fiberglass, glass, and steel applications. Flexx Flow serves food processing markets identical to Wiremation. Under the acquisition, all product brands will be retained and rolled up under the Fenner Precision Polymers portfolio of belting and high-value component solutions.

"All of these brands overlap very well with the products and technologies offered at Fenner," Slingluff added. "Fenner's largest product categories are belting and high-valued components. Hoyt fits perfectly into our high-valued components business and obviously Lumsden fits into our belting business."

New Opportunities

When COVID hit it became evident that you needed to be in some recession-proof industries, and nothing is more recession-proof than the food and beverage market according to Slingluff.

"Food and beverage and material handling are markets that will greatly improve with the acquisition of Lumsden," Slingluff said. "We like where these product segments fit into our overall growth strategy."

"They sell the same way we do which is value," he added. "Lumsden is not the lowest cost producer, they never intend to be. The products they make drive a lot of value and lower cost of ownership, and that is exactly what we're doing here at Fenner."

"Without question or reservation, this partnership is just the move we envisioned to take our business to the next level," said Glenn Farrell, CEO, Lumsden Corporation in the official press release. "We've considered offers prior to this in the past, but always in the back of our mind was the thought of how ideal it would be to partner with Fenner, where we share the same location, similar markets, and the simple fact that they are such a trusted industry leader."

Technology & Innovation

The acquisition allows both organizations the room to develop new products and technologies in the future. For example, Slingluff said that Lumsden is doing some things around shaping and finishing that is a little bit different in the industrial marketplace. "They also have some patented belting products that drive performance and longevity," he added.

"There's opportunities in this area as well," Slingluff said.

"Product development is all about getting away from metal into longstanding materials. Obviously with our relationship with Michelin, we intend to leverage that very heavily in the coming years."

"Bundling sales will also be the norm," Krecek added. "You'll see an assembly line with Lumsden belts, Fenner PowerMax pulleys, tensioners, etc. It will be our ability to bring in a bundled solution to the customer, so they don't have to look at equipment from multiple sources."

"We expect to see a significant investment in infrastructure from the federal government," Krecek said. "A lot of the raw materials for infrastructure are serviced by belts or wire cloth. Potentially, these new products and technologies will allow us to take advantage of some of these investments once they're approved."

Infrastructure investments over the next decade include growth in areas like crushed stone, sand, and gravel.

Also, the acquisition of Lumsden creates a natural extension into the company's R&D process with polymer development, providing opportunities to engineer next-generation materials.

"We can bring a whole lot to the table as far as R&D is concerned," Slingluff said. "With Michelin behind us, there's a lot of support. We think we can take some of Lumsden's technologies and try some new things."

With Tires, Around Tires and Beyond Tires

This sums up Michelin's current mission statement. Krecek said that Fenner fits in the 'Beyond Tires' objective.

"We plan to grow as fast as we can and expand beyond our core product offerings to other applications. The growth potential and market share gains all played a critical role in this decision," Krecek said. "And we will definitely look closely at other potential acquisitions in the near future."

The Future of Belt Applications

Belting, in general, is evolving in the transfer from metal to composites. Total cost of ownership is playing a much bigger

role as the longevity of cleaner, more efficient belting products takes center stage.

"Belting fits perfectly in automation," Slingluff said. "The more automated these manufacturing facilities become, the more they're relying on the movement of materials through robotics. You'll see some new innovations and opportunities in moving and conveying in the future."

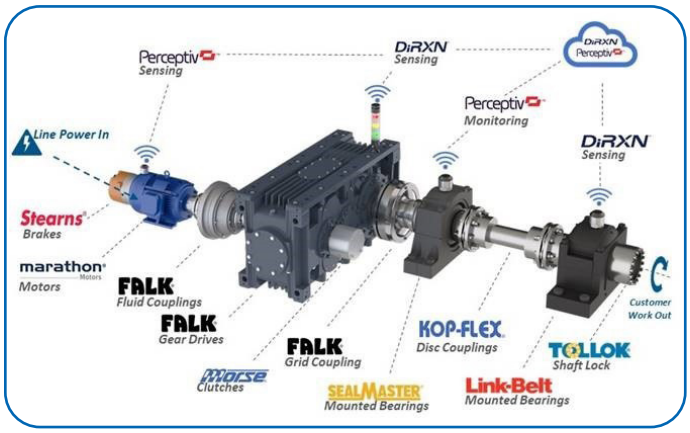
www.fennerppd.com
www.lumsdencorp.com

Regal Rexnord Corporation

EXPANDS RANGE OF PRODUCTS AND DIGITAL SOLUTIONS

Regal Beloit Corporation has completed the merger with Rexnord Process and Motion Control (PMC) to become Regal Rexnord Corporation.

The company's new name signifies bringing together the complementary strengths of two strong businesses and highlights their now common future as a leader in the engineering and manufacturing of power transmission solutions and high-efficiency electric motors and systems.



The new company will be comprised of four distinct business segments: Motion Control Solutions, Climate Solutions, Commercial Systems and Industrial Systems. Together, these enable air moving and HVAC solutions that keep people comfortable; agricultural and foodservice equipment that keeps the world fed; mining and manufacturing operations that keep the world moving; and conveying solutions that help keep e-commerce flowing.

Combining these two companies creates an expanded range of products to serve customers across the entire industrial powertrain. This new portfolio includes highly regarded 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 world-class industrial internet of things (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.

At a time when global supply chains are constrained, the combined company will leverage manufacturing facilities on five continents to help increase reliability, quality, response time and product availability.

Louis Pinkham, CEO of Regal Rexnord, commented "For over 125 years, Regal has consistently provided our customers with reliable, high quality powertrain products and solutions. Now, with the addition of Rexnord PMC, we are taking a tremendous positive step forward in Regal's ongoing transformation, positioning the new Regal Rexnord company to create significant value for all our customers. We will provide more robust industrial powertrain solutions — comprised of our motors and critical power transmission components — to enable a range of efficiency and productivity gains for our customers. By providing more energy-efficient solutions, developed with greater intention, especially when it comes to leveraging voice of the customer, Regal Rexnord is also now in a better position to fulfill our business purpose: creating a better tomorrow by energy-efficiently converting power into motion."

www.regalrexnord.com/regal-rexnord-integration

FVA and AVL

COLLABORATE ON VIRTUAL GEAR DESIGN SOFTWARE TOOLS

FVA and AVL have announced they are joining forces to support their customers in developing virtual transmissions at the highest level. The transition to electric drives and increasing virtualization pose new challenges for drive technology companies on a daily basis.

"By combining the FVA-Workbench's proven design analysis capabilities with AVL's multiphysics simulation suite, we have created the most comprehensive gearbox analysis solution available on the market. We now cover the entire development process, from concept to calibration, with high-quality methods and models. Our cooperation with the AVL-Network allows us to offer our leading products to customers around the world," Norbert Haefke, managing director, FVA GmbH.

New developments in these areas will be available as further technical details come into play.

www.fva-service.de/de/software/

PTDA

HONORS MEMBERS DURING 2021 INDUSTRY SUMMIT

The Power Transmission Distributors Association (PTDA) honored several members during its recent Industry Summit that took place in Atlanta, GA on October 22, 2021.

Warren Pike Award

The PTDA has named Pamela Kan the 30th recipient of its Warren Pike Award for lifetime achievement in the power transmission/motion control (PT/MC) industry. She received her award during the PTDA 2021 Industry Summit October 22 in Atlanta.

For Pamela, what began as a short-term assignment working for her father, Bud Wisecarver, evolved into more than three decades working for Bishop-Wisecarver Corporation, which provides linear and rotary motion solutions. Today, Pamela is the sole proprietor of the certified woman-owned company.

Pamela's role with PTDA began in 2003 with a committee assignment. She progressed through several volunteer roles, including serving on the Industry Summit Planning task force three times, including for the 2021 program, as a PTDA Foundation Trustee for five years and leading the PTDA Manufacturer Council as chair in 2011.

During her acceptance speech Pamela shared: "The number one core value of my own company is to preserve our family culture. Likewise, the PTDA family grows and changes, but the family culture has remained the same. We support one another, provide opportunities for growth and success, and embrace the different views and people that help us be our best. I'm proud to be a member of this PTDA family and am excited to be part of the ongoing growth and changes in the next 20 years."

Robert K. Callahan Future Leaders Award

A past president and 25-year PTDA Foundation Trustee, Bob Callahan (formerly SENQCIA MAXCO LLC) was passionate about the mission of the PTDA Foundation. Bob passed away in early 2021 and, in recognition of his commitment to the advancement of new talent within the power transmissions/motion control (PT/MC) industry, the PTDA Foundation created the Robert K. Callahan Future Leaders Award. This award recognizes a young leader who exhibits a true passion for and desire to grow within the industry. The inaugural recipient of this award is Chris Gumas of Ruland Manufacturing Co., Inc.

Gumas joined Ruland in 2010 and today is the director of marketing, managing the company's global distributor relationships, website and day-to-day commercial operations. Throughout his eleven-year tenure with Ruland, Gumas has never ceased to seek opportunities to advance his knowledge of the PT/MC industry, including his regular participation at the PTDA Leadership Development Conferences. He exudes an energy and passion that is best seen in his ability to connect with individuals across all levels of the industry — from those beginning their careers to seasoned PTDA leaders.

Wendy B. McDonald Award

This year's recipient of the Wendy B. McDonald Award is Barbara J. Ross of Garlock Sealing Technologies. Ross began her career at Garlock in 1973, working alongside her father. What started as a summer job evolved into a 46-year career in the PT/MC industry.

Pamela Kan, (left) accepts the Warren Pike Award from Ann Arnott.

At Garlock, Ross honed her skills working for various departments — from finance to marketing to administration — before being named the company's first female distribution center manager. With this distinction came a move from upstate New York to Atlanta. Additional career advancements within the industry and relocations proved promising for Ross, who soon discovered her niche in marketing. In 2014, Ross became the VP of sales and marketing for Garlock's Rotating Seal Division, a role in which she continues to lead and find fulfilment.

Her success in the PT/MC workforce is what she considers one of her greatest achievements. She draws inspiration from the words of friend, colleague and award namesake Wendy McDonald: "You have to work at something to make it a success." Ross continues to channel her passion into helping others in the PT/MC industry carve their own path to success. She says the key is to "be prepared, listen, be responsive, do what you say you're going to do and admit if you don't know something."

www.ptda.org

January 3–7–SciTech 2022

San Diego, CA. From its creation in 1963, the American Institute of Aeronautics and Astronautics (AIAA) has organized conferences to serve the aerospace profession as part of its core mission. Spanning over 70 technical discipline areas, AIAA's conferences provide scientists, engineers, and technologists the opportunity to present and disseminate their work in structured technical paper and poster sessions, learn about new technologies and advances from other presenters, further their professional development, and expand their professional networks. The AIAA Science and Technology Forum and Exposition (AIAA SciTech) has continued to grow in each succeeding year, drawing participants from around the globe. SciTech participants tackle the most pressing issues impacting the future of aerospace, while the technical program presents innovative research and technologies that offer solutions. The newly developed hybrid format allows attendees to attend, present and interact virtually or in-person. For more information, visit *www.aiaa.org*

January 25–27–AGMA Fundamentals of Gear Design and Analysis

Clearwater Beach, FL. Offered by AGMA, attendees will gain a solid and fundamental understanding of gear geometry, types and arrangements, and design principles. Starting with the basic definitions of gears, conjugate motion, and the Laws of Gearing, learn the tools needed to understand the inter-relation and coordinated motion operating within gear pairs and multi-gear trains. Basic gear system design process and gear measurement and inspection techniques will also be explained. In addition, the fundamentals of understanding the stepwise process of working through the iterative design process required to generate a gear pair will be reviewed. Learn more here: *www.agma.org/education/advanced-courses/2022-fundamentals-of-gear-design-and-analysis/*.

January 25–27–IPPE 2022

Atlanta, GA. The International Production & Processing Expo is the world's largest annual poultry, meat and feed industry event of its kind. A wide range of international decision-makers attend this annual event to network and become informed on the latest technological developments and issues facing the industry. The 2022 IPPE will provide a full week of education programs, in addition to new technology, events on the show floor and networking opportunities with key leaders from the animal food, meat and poultry industries. The vast trade show floor will showcase the most current innovations, equipment and services used in the production and processing of animal food, meat and poultry products. Combining the expertise from the American Feed Industry Association, North American Meat Institute and U.S. Poultry & Egg Association, IPPE will also feature countless hours of dynamic education sessions focused on the latest industry issues. For more information, visit *ippexpo.org*.

March 5–12–IEEE Aerospace Conference 2022

Big Sky, MT. The International IEEE Aerospace Conference, with AIAA and PHM Society as technical cosponsors, is organized to promote interdisciplinary understanding of aerospace systems, their underlying science and technology, and their applications to government and commercial endeavors. The annual, week-long conference is set in a stimulating and thought-provoking environment. The 2022 conference will be the 43rd in the series. Plenary sessions feature internationally prominent researchers working on frontiers of science and engineering that may significantly impact the world we live in. Registrants are briefed on cutting edge technologies emerging from and intersecting with their disciplines. Each year, a large number of presentations are given by professionals distinguished in their fields and by high-ranking members of the government and military. For more information, visit *www.aeroconf.org*.

March 21–24–Gear Dynamics and Gear Noise Short Course 2022

Columbus, OH. The purpose of this unique short course is to provide a better understanding of the mechanisms of gear noise generation, methods by which gear noise is measured and predicted, and techniques employed in gear noise and vibration reduction. Over the past 40+ years about 2,450 engineers and technicians from over 380 companies have attended the Gear Noise Short Course. The course is of particular interest to engineers and technicians involved in the analysis, manufacture, design specification, or utilization of simple and complex gear systems. Industries that find this course helpful include the automotive, transportation, wind-energy, process machinery, aircraft, appliance, general manufacturing, and all gear manufacturers. The course material is covered in such a way that the fundamentals of gearing, gear dynamics, noise analysis and measurements are covered first. This makes the course appropriate to the gear designer with minimal knowledge of noise and vibration analysis as well as to the noise specialist with little knowledge of gears. For more information, visit *www.nvhgear.org*.

March 22–24–Gearbox CSI

Concordville, PA. A good understanding of individual failure modes and the failure scenarios that led to the actual system failure is an essential skill to designing gear/bearing systems that will operate properly for their full design life. In this course, instructors will define and explain the nature of many gear and bearing failures and discuss and describe various actual failure scenarios. In addition, a detailed primer on bearing technology prefaces the failure scenario discussions. Attendees will gain a better understanding of various types of gears and bearings. For more information, visit *www.agma.org/education/advanced-courses/2022-gearbox-csi/*.

Power Transmission Engineering

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

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

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1. Publication Title	2. Publication Number	3. Filing Date
POWER TRANSMISSION ENGINEERING	2 3 3 1 _ 2 4 8 3	10/1/2021
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13. Publication Title: POWER TRANSMISSION ENGINEERING — 14. Issue Date for Circulation Data Below: SEPTEMBER 2021

15. Extent and Nature of Circulation			Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies (Net press run)			14,187	14,736
b. Legitimate Paid and/or Requested Distribution (By mail and outside the mail)	(1)	Outside County Paid/Requested Mail Subscriptions stated on PS Form 3541. (Include direct written request from recipient, telemarketing, and Internet requests from recipient, paid subscriptions including nominal rate subscriptions, employer requests, advertiser's proof copies, and exchange copies.)	5,358	5,715
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	(4)	Requested Copies Distributed by Other Mail Classes Through the USPS (e.g., First-Class Mail®)	-	-
c. Total Paid and/or Requested Circulation (Sum of 15b (1), (2), (3), and (4)) ▶			5,643	6,024
d. Non-requested Distribution (By mail and outside the mail)	(1)	Outside County Nonrequested Copies Stated on PS Form 3541 (include sample copies, requests over 3 years old, requests induced by a premium, bulk sales and requests including association requests, names obtained from business directories, lists, and other sources)	8,147	7,905
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e. Total Nonrequested Distribution (Sum of 15d (1), (2), (3) and (4))			8,223	8,398
f. Total Distribution (Sum of 15c and e) ▶			13,866	14,422
g. Copies not Distributed (See Instructions to Publishers #4, (page #3)) ▶			321	314
h. Total (Sum of 15f and g)			14,187	14,736
i. Percent Paid and/or Requested Circulation (15c divided by 15f times 100) ▶			41%	42%

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16. Electronic Copy Circulation	Average No. Copies Each Issue During Previous 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Requested and Paid Electronic Copies ▶	3,083	2,891
b. Total Requested and Paid Print Copies (Line 15c) + Requested/Paid Electronic Copies (Line 16a) ▶	8,832	8,915
c. Total Requested Copy Distribution (Line 15f) + Requested/Paid Electronic Copies (Line 16a) ▶	16,949	17,313
d. Percent Paid and/or Requested Circulation (Both Print & Electronic Copies) (16b divided by 16c × 100) ▶	52%	52%

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17. Publication of Statement of Ownership for a Requester Publication is required and will be printed in the issue of this publication. December 2021

18. Signature and Title of Editor, Publisher, Business Manager, or Owner — Date

Randy Stott, Publisher & Editor-in-Chief — 10/1/2021

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Destination Dubai

Nidec provides control system for the largest observation wheel in the world

Matthew Jaster, Senior Editor

Ain Dubai reimagines the observation wheel experience in Dubai, offering more than just a 360° city view, they offer an entirely unique sightseeing attraction.

Standing at a height of over 250 meters, higher than any other observation wheel in the world, the Ain Dubai boasts 48 luxurious, brightly-lit cabins that are larger than two double-decker buses placed side by side, and can carry up to 1,750 people at a time. It took 11,200 tons of steel to build (33% more than the Eiffel Tower).

Nidec ASI and its experts at the Montebello Vicentino plant, a world center of excellence in the development of cutting-edge systems for the evolution of cableway transport, were involved in developing the three basic components that make up the "heart" of the wheel.

The Group has been involved in creating the wheel's entire control system (ICS - Integrated Control System). The ICS is similar to those used in cableways and can be considered the real "brain" of this attraction. It controls all the wheel's movement, guaranteeing the highest safety standards in the world for the protection of people. The Group has also supplied the communication system that incorporates the latest technologies in terms of digital radio transmission: it acts as the wheel's "nervous system", connecting every component, from the motors to the cabin interiors, enabling the relay of control and entertainment information.

Nidec ASI technologies also ensure protection against cyberattacks, which could occur in a project like this, adopting cutting-edge in-field solutions. The third element developed by Nidec ASI is the highly sophisticated multimedia system found inside the cabins that plays audio and video content and allows passengers to connect to the Internet, guaranteeing the best possible on-board entertainment. There are numerous on-board experience options which can be customized to suit different audience types, ranging from the organization of private events to attending exclusive parties, from unique culinary itineraries to packages more suited to families or more romantic experiences, all of which can be further enhanced by the diffusion of personalized multimedia content through this dedicated system.

"We are thrilled to have contributed to this successful initiative, which will boost tourism in Dubai. This city is not new to surprising us with attractions unlike any others in the world, and the record-breaking Ain Dubai could only have been built in this showcase of wonders. Its realization presented us with enormous challenges, which required us to observe maximum technological standards. Being able to complete this project, despite the pandemic and the closure of Dubai for several months, makes us particularly proud, and represents further confirmation of our Group's leadership in the creation of automation systems applied to passenger transportation," said Dominique Llonch, CEO of Nidec ASI and Chairman of Nidec Industrial Solutions.

The Group has played a fundamental role in over 600 installations located in every corner of the world, such as the Moscow cable car — inaugurated during the last World Cup — that connects the Luzhniki Stadium to the scenic viewing point at Moscow State University, and the Faloria cableway in Cortina d'Ampezzo, which will take tourists and winter sports enthusiasts to high altitude during the Milan-Cortina 2026 Winter Olympics. **PTE**

www.aindubai.com/.

Dear Santa,

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All my engineering friends are specifying it and saying it's the hottest electronic product this year. It should make me look really good, so hold off on that coal for my boss's stocking (wink).

Thanks, Santa... you rock, dude!
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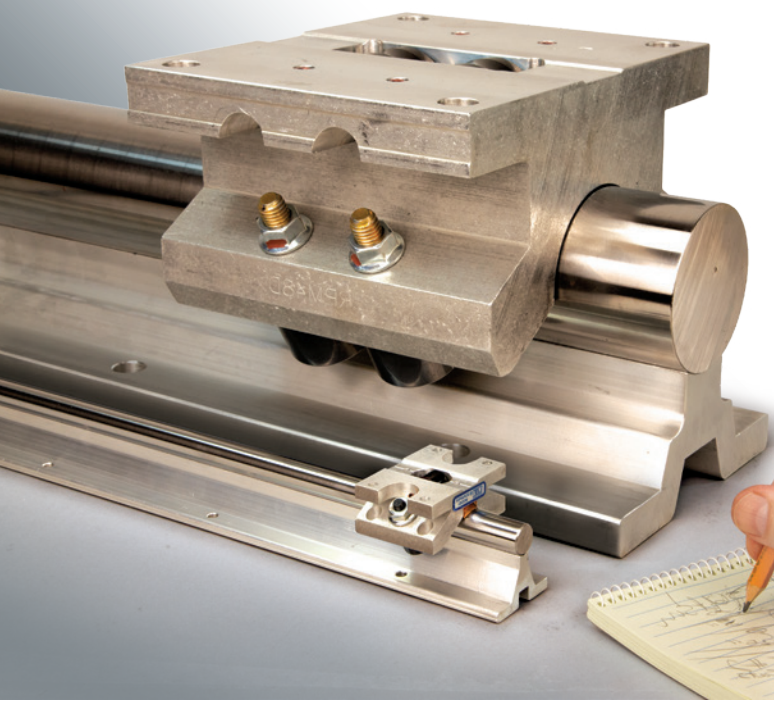

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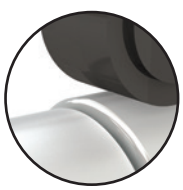

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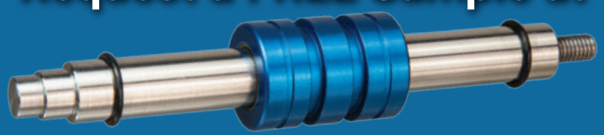

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