

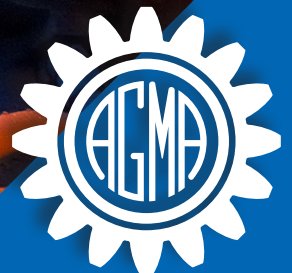
Power Transmission Engineering®

AUGUST 2021

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**GEAR MANUFACTURERS
AT M+PT EXPO**



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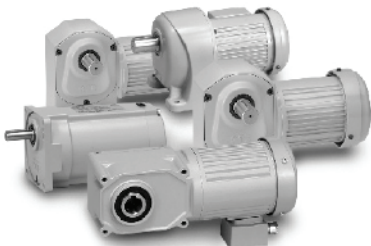
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Power Transmission Engineering

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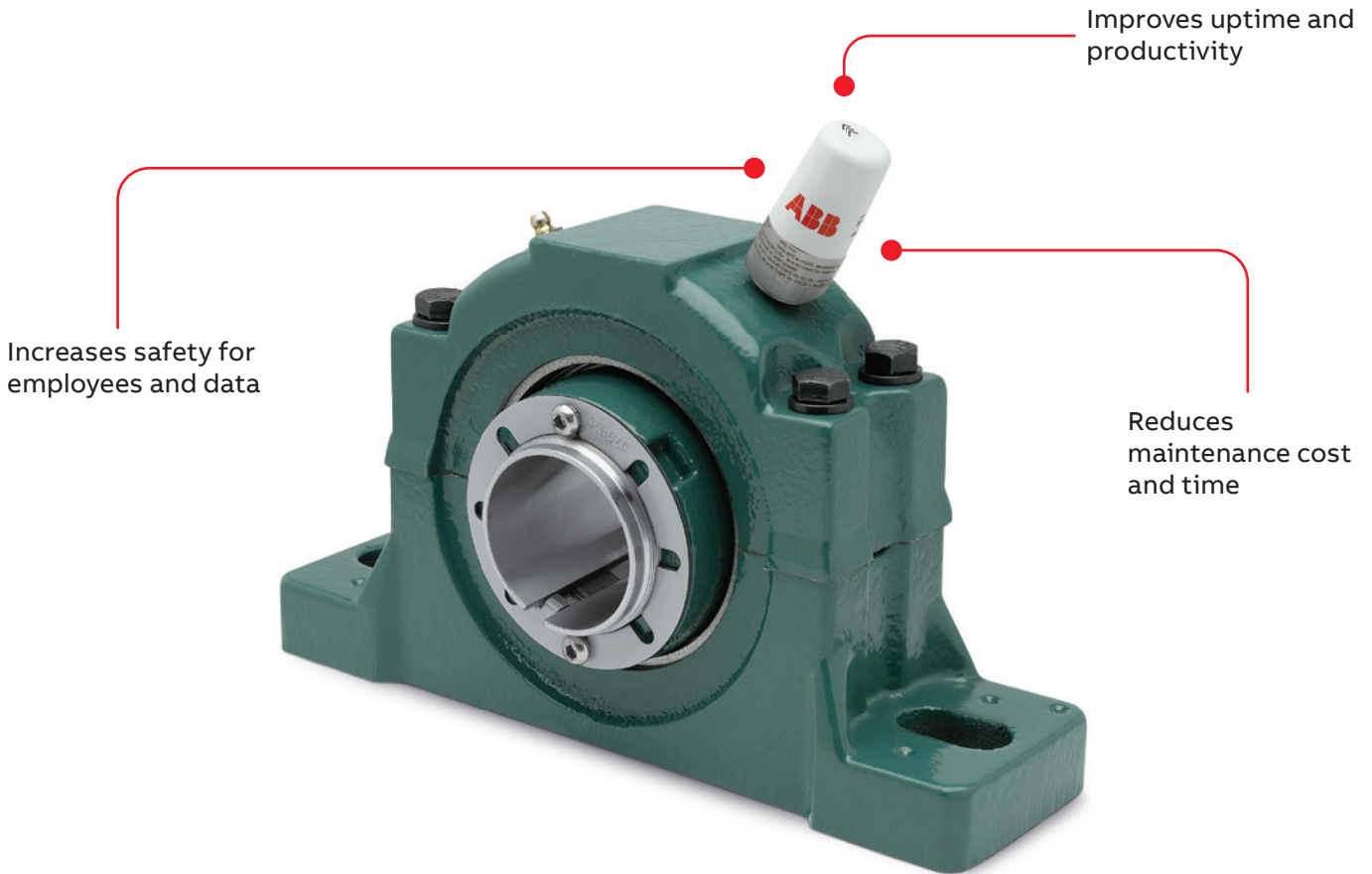
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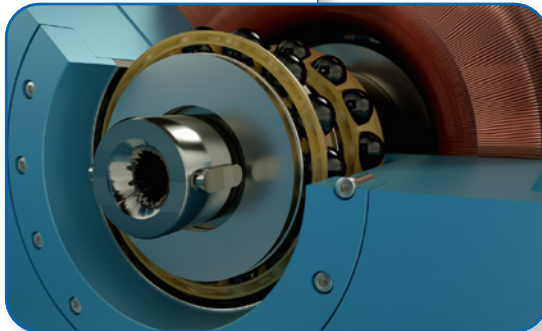
The new ABB Ability™ Smart Sensor for mounted bearings is an easy-to-use, condition monitoring tool which provides a quick health indication on bearings in operation without requiring employees to touch the equipment. Evaluating bearings on a regular basis allows vibration and temperature trends to be analyzed and outliers to be detected before a failure occurs.

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Maximizing Bearing Performance

The opportunity to improve product design separates market leaders from the competition. Brand loyalty, perceived value, manufacturing technology, and research and development can play a significant role in identifying issues that are important to customers. Since 1902, Carrier has created a rich history of product innovation in the heating, air-conditioning and refrigeration industries. They continue to evolve with assistance from companies such as SKF.



www.powertransmission.com/blog/maximizing-bearing-performance/

The Sustainable Shop Floor



Energy from renewable sources? Natural resource conservation? Reduction in pollution and waste? Energy efficient components? Many talk a good game when it comes to sustainability in manufacturing, but there's more work that needs to be done. Baby steps are just as important as taking the lean, clean, and green leap into the future. Learn more here:

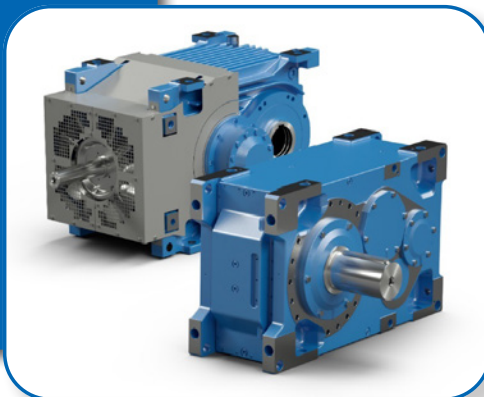
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PTE Videos

NORD Provides Drive Technology for Grain Industry

NORD DRIVESYSTEMS provides reliable drive technology for the grain industry all over the world. In 2019 the company Lachenmeier Monsum A/S installed a grain terminal with a storage capacity for 40,000 tons of grain in Fredericia, DK. Learn more here:

www.powertransmission.com/videos/NORD-Provides-Drive-Technology-for-Grain-Industry/



Power Transmission Engineering



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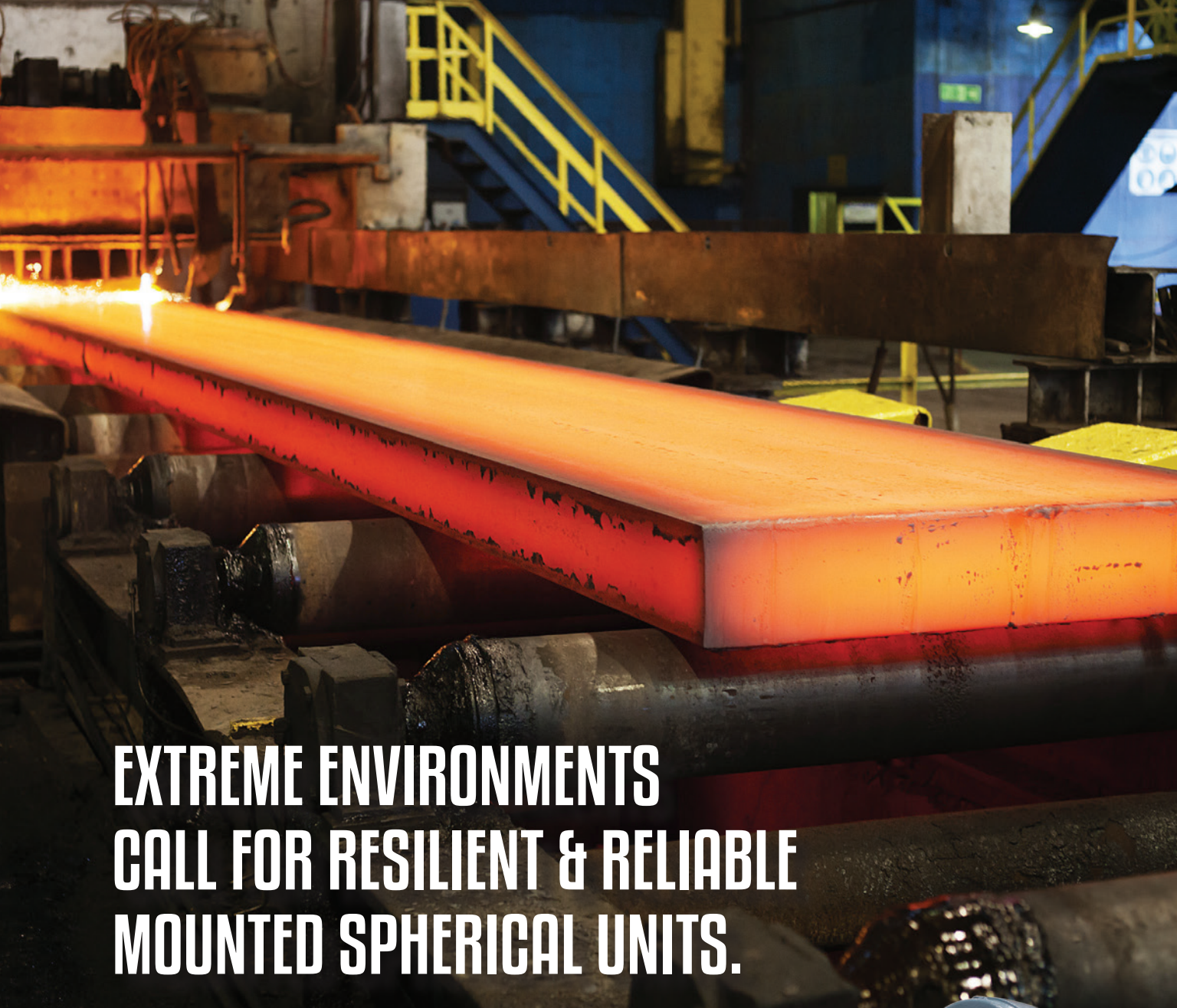
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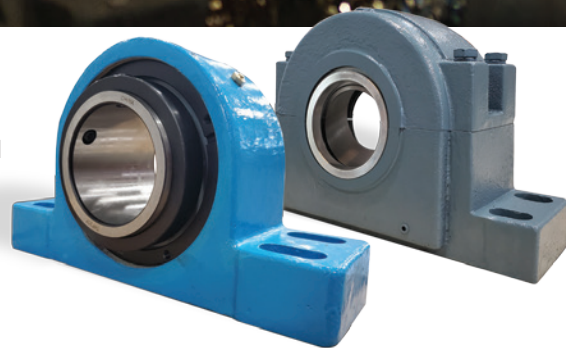
Michael Goldstein founded Gear Technology in 1984 and Power Transmission Engineering in 2007, and he served as Publisher and Editor-in-Chief from 1984 through 2019. Michael continues working with both magazines in a consulting role and can be reached via e-mail at michael@geartechnology.com.



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Spreading the Word

The core of our mission here at *Power Transmission Engineering* is to publish information related to the technology of mechanical power transmission, and we're always looking for ways to expand and improve how we do so.

In the old days, to publish meant simply printing articles in the magazine. And we believe the printed word will always be central to what we do. Many of you have told us you still prefer to hold the magazine in your hands or spread it out on your desk. Much of what we publish requires quiet time, concentration and focus to truly absorb and appreciate the information. So rest assured, we'll continue producing this publication on paper for as long as you keep asking for it that way.

At the same time, the world has changed, and many of you want access to information in different ways now. You prefer to receive shorter updates in your e-mail or on social media. You want to watch technology-related videos or read the magazine on your phone or tablet. Believe me, we get it. And we're constantly working to improve how we bring you the same high quality technical information in digital formats.

Coming up soon, we have a great opportunity to do just that. At the Motion+Power Technology Expo (September 14-16 in St. Louis), we'll be exhibiting along with the rest of the American Gear Manufacturers Association team in booth #2813. Our editors will be roaming the floor and conducting live interviews with technical experts from a wide variety of companies, including the many gear, gear drive, bearing and other mechanical power transmission suppliers who will be there. But instead of recording the answers in those cute little notebooks reporters like to use, we'll be video recording these interviews so you can hear for yourselves what the experts have to say.

We absolutely hope to see you at the show. It's a great event for anyone who routinely designs, manufactures or specifies gears, because the complete supply chain will be represented. But we understand that even in years when the world has not been trying to emerge from a pandemic, many of you have been unable to make it. So this year we're going



to bring the show to you.

We're going to ask the questions you would ask if you were there. We're going to help you understand the technology in ways that will allow you to make informed decisions about which suppliers to use. We're going to spread the word about the latest technologies.

So if there are certain subjects you want us to tackle, or even certain exhibitors you want us to interview, please let me know (stott@agma.org) so I can incorporate your needs into our schedule. If you have questions you need answered, we'll ask the appropriate experts. It will be almost like having a remote-control editor at your disposal!

Likewise, if you are exhibiting at MPT Expo and you have experts on your team you'd like us to interview, the best way to make sure it happens is to e-mail me at stott@agma.org so we can schedule a time for our crew to visit your booth.

You can learn about some of the gear manufacturers who will be exhibiting at the show by reading our article on page 28. We'll also have more coverage in the August issue of *Gear Technology*, the September issue of *PTE* or online at powertransmission.com and geartechnology.com. For more information, you can also visit motionpowerexpo.com.

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The Bearing Marketplace

<https://qbcbearings.com>

TSN

PROVIDES SMART MANUFACTURING COMMUNICATION SOLUTIONS

The Smart Factories of the future are highly productive, flexible and responsive because of their ability to leverage the power of data, which can offer a unique understanding of what is happening on the factory floor in real-time. As a result, companies can run automated processes to ensure smooth operations at all times, maximizing their efficiency. The backbones of such systems are their networks, which connect every part within a plant or enterprise to share key information. In order to support digital manufacturing functions, these infrastructures should be able to ensure the large volume of data generated is transmitted with high reliability and in a timely manner. The move towards gigabit bandwidth is further supporting these requirements.

TSN (Time-Sensitive Networking) can provide further support and help businesses create data-driven operations. Christian Bergdahl, product marketing manager at HMS Industrial Networks explains: “The most emphasized feature of this technology is its ability to turn standard industrial Ethernet into a real-time communications system with extremely low jitter and latency. Therefore, it provides the key network technology to support the latest data-driven solutions and smart manufacturing applications. These, in turn, are essential to help companies enhance productivity by creating responsive and flexible shop floors.”

He continues: “TSN will make industrial Ethernet deterministic by design and provide the basis of converged networks. In effect, the technology is being defined by the IEEE 802.1 specifications, which will set up a common, unified solution. As a result, any user will be able to benefit from a highly reliable and responsive network, whose nature supports interconnectedness, independently of vendor-specific solutions. This ultimately ensures openness and interoperability among automation devices and systems, simplifying the creation of well-linked plants and enterprises.”

Furthermore, TSN has the ability to bring different parts of an enterprise, such as the operational technology (OT) and information technology (IT) sectors closer together. “The technology was originally developed for transferring audio and video streams in commercial applications. Only later, this solution has been looked at to support industrial automation systems. As a result, TSN applications in a given sector will be influenced by the developments in another segment, shaping and converging the future of the technology and industries themselves,” adds the HMS Industrial Networks specialist. This unique feature will also play a crucial role in enhancing the acceptance of TSN.

Automation system builders and end users are highly perceptive and well aware of the potential of TSN, particularly its ability to provide a unified way towards interoperability. Therefore, many companies are actively looking forward to

adopting this technology. Furthermore, it is a well-accepted concept that TSN will certainly become a must-have in the short- to mid-term. In fact, the extensive roll out of innovative industrial Ethernet solutions is a matter of when, not if — and businesses are ready to act now.

Currently, the creation of TSN-based solutions is experiencing a growth phase and it is certainly a thrilling time for the technology specialists. Bergdahl comments: “Fieldbuses and conventional Ethernet have been established for many years. Now that the innovation of TSN is here, engineers are up for a new challenge as they develop new products with ground-breaking capabilities. It is truly inspiring to see how committed and motivated these teams are.”

A challenge in driving the TSN revolution may be shaping successful collaborations between automation vendors, according to Bergdahl. “As the key element of TSN is interoperability, specialists need to be willing to collaborate closely



to develop suitable systems and migration solutions. Within such a framework, existing networks of key automation players, such as the CLPA, are on the right path and have a competitive advantage”.

“Being part of the CLPA has always been extremely beneficial. With TSN, we are witnessing a number of unique advantages. In addition to being able to rely on a community of leading automation experts, we can be the first to develop TSN-compatible devices by utilizing the CC-Link IE TSN specifications. This is the first network technology incorporating the innovative TSN standards that was released to the market. By offering the earliest solutions with TSN, we can enhance our role and acceptance in the automation sector, particularly in Asia, where the CLPA’s technologies are de facto standards. The first product appearing from HMS in mid-2021 will be the Anybus CompactCom for CC-Link IE TSN, which will allow device makers to easily implement this new promising technology.”

www.cc-link.org



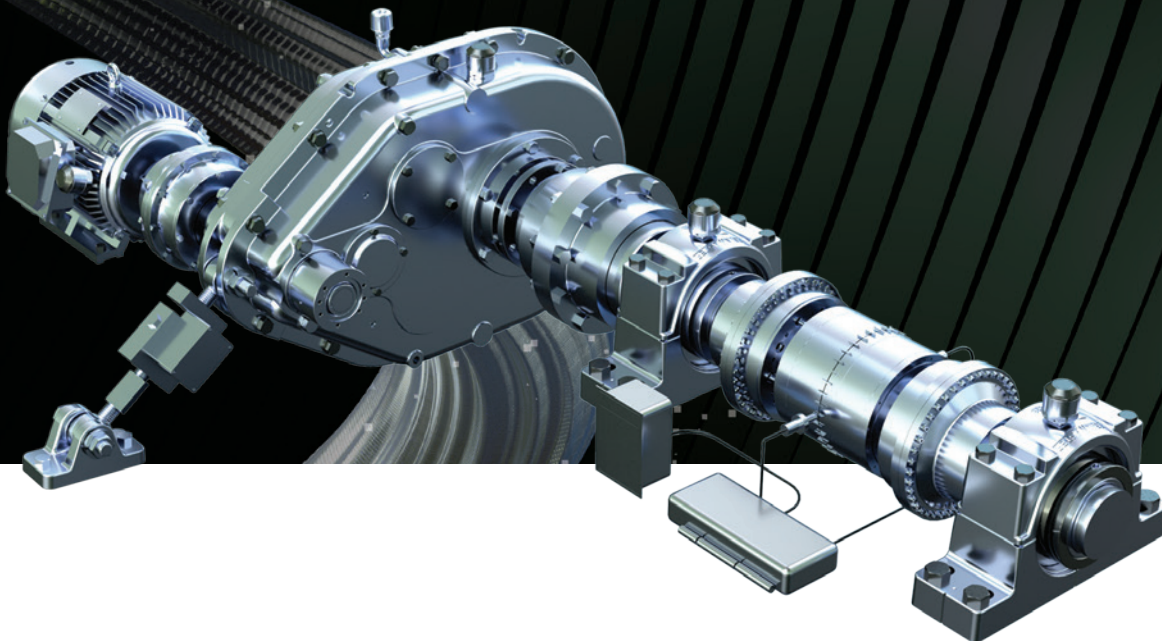
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Bodine Electric

PROVIDES EXPLOSION-PROOF AC AND BLDC GEARMOTORS AND MOTORS

Bodine Electric Company recently introduced forty new Ex-Proof AC and BLDC gearmotors and (4) new motors, that are UL listed for use in environments where ignitable concentrations of flammable gases, vapors or liquids are likely to exist under normal operating conditions. These new CI/D1 geared motors combine Bodine's high-performance type 34R6 (inverter-duty AC) or type 34B6 (brushless DC) motors with an integral parallel shaft type FX gearhead. Typical applications include chemical injection pumps for the oil and gas industry, automated equipment for use in aircraft hangars, petroleum refineries, dry cleaning plants, fuel servicing areas, chemical processing (cannabis distillation), or industrial coating and mixing facilities.

These new gearmotors and motors meet National Electrical Code (NEC) Class I, Division 1 requirements, and are rated for use in areas where groups C and D flammable liquids are commonly found. The gearmotors meet UL temperature codes T3C and T4A. Both the type 34R6-FX (AC) and the 34B6-FX (BLDC) gearmotors and 34-frame motors are rated IP-66, meaning they can safely withstand water jets from any direction.

The initial product launch includes 40 standard gearmotor models with gear ratios from 5:1 to 300:1 with speeds from 5.3 to 560 rpm. Rated torque ranges from 46 lb-in (5Nm) to



350 lb-in (40 Nm). Bodine Ex-Proof gearmotors and motors are available with low-voltage (12 or 24 VDC) brushless DC windings, and 230VAC or 460VAC inverter-duty, 3-phase windings. The CI/D1 AC and BLDC motors are available with two NEMA C face mounting options.

The model 0931 base mount kit fits both the new type 34R6BXPP-FX (AC) and 34B6BXBL-FX (BLDC) gearmotors, as well as on the corresponding AC and BLDC, CI/D1 motors. Bodine type 34R/34B AC and BLDC, CI/D1 motors meet NEMA-56C mounting specifications when the optional base mount kit 0931 is installed.

Bodine's new Class I Division 1 gearmotors and the 0931 base mount kit are available through Bodine's extensive

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Bosch Rexroth

OFFERS FAST, POWER-DENSE HYDRAULIC MOTOR

The smallest of the Hägglunds hydraulic motors from Bosch Rexroth has been transformed. The Hägglunds Atom takes over from the existing Hägglunds CAB — supplying not only more revolutions per minute, but also far more power than motors of similar size. The result is a tiny, power-dense package ideal for mobile, marine and recycling applications.

Revamped and renamed, the Hägglunds Atom is a powerhouse in miniature, with a maximum torque of up to 13.6 kNm and a specific torque of 40 Nm/bar. Because it supplies full torque at speeds up to 400 rpm, it has a maximum power of 394 kW that outstrips other motors in its class.

“Never has so much power been packed into a motor this small,” says Wolfram Ulrich, vice president sales Hägglunds products and solutions at Bosch Rexroth. “The Hägglunds Atom, with its substantially higher torque and power, is a motor that deserves its name — unthinkable small and light, but with the power to change everything for customers.”

Among those who will benefit from the Hägglunds Atom are customers in mobile, marine and recycling applications. The compact and lightweight motor fits on a winch on land or at sea, and can easily handle shock loads at peak pressure of up to 420 bar. That opens the door to smaller shredders and other machines in tough and unpredictable applications.

“The Hägglunds Atom is rugged and robust, like our larger Hägglunds motors,” says Ulrich. “That makes it just as dependable as it is versatile.”

In fact, the Hägglunds Atom is the first of many new names that will appear in the Hägglunds family. In a departure from technical designations, all motors will soon be renamed after natural and scientific phenomena. That reflects not only the extensive development that has occurred since their introduction, but also illustrates its key characteristics today.

“Striking and memorable names will help guide customers to the Hägglunds motor that meets their needs,” says Ulrich. “In a way, this is a strong return to form. The original Hägglunds motor was the Hägglunds Viking — a motor and a name that have never been out of popular use.”

www.boschrexroth-us.com/hagglundsatom



NTN

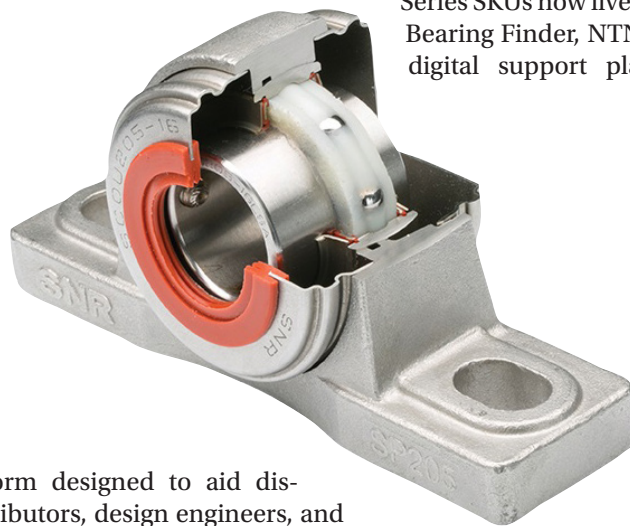
REVAMPS SENTINEL SERIES

NTN Bearing Corporation of America has announced that its Sentinel Series product line has been revamped to encompass a more expansive offering. NTN’s Sentinel Series is a premium line of corrosion-resistant products ranging from deep groove ball bearings, bearing inserts, and mounted units developed for the harsh conditions of the food & beverage industry. Products are available in numerous combinations of housings — including the recently added three-bolt flange —, protective covers, sealing options, and food-grade standard or solid-lubrication grease. Whether an application requires the ultimate wash-down protection of stainless steel units, caustic resilience of thermoplastic housings or the value performance of zinc, Sentinel Series provides a family of food & beverage market solutions to improve overall equipment effectiveness, increase production, and provide value.

“This is an exciting announcement for NTN,” said James Misch, director of marketing and technical services, NTN. “We have been working on the renovation of our Sentinel Series line for quite a while and are thrilled to see the hard work culminating in this moment. We will continue to update and expand the Sentinel Series line and its’ supporting literature to ensure that we are offering our customers the widest breadth of food & beverage industry solutions while supplying them with the information they need to safeguard against downtime.”

As part of the relaunch, a new Sentinel Series catalog that gives a broad overview of the updated line has been created.

Additionally, 256 Sentinel Series SKUs now live in Bearing Finder, NTN’s digital support plat-



form designed to aid distributors, design engineers, and end users in finding the perfect bearing or related product to use in any application. In total, Bearing Finder now houses 39,945 SKUs.

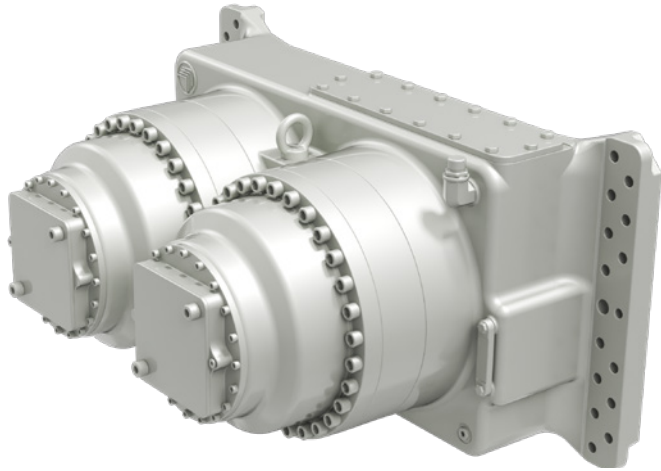
Bearing Finder is hosted on a proprietary platform that offers a customizable part search tool, interactive and downloadable CAD illustrations, comprehensive part interchanges, and exhaustive data sets. It’s part of NTN’s industry-leading suite of training and cataloging entities.

NTNAmericas.com

Bonfiglioli

INTRODUCES NEW PLANETARY DRIVE SERIES

Bonfiglioli presents the new R3 planetary gearbox series, designed specifically for recycling machines such as shredders and others. The planetary drives are available in four sizes with a torque range from 129,000 up to 370,000 Nm and gear ratios from 56 to 117. The R3 series is compact and powerful. Their planetary gear train makes them the ideal choice for all severe duty applications where shock loads and impacts are the rule rather than the exception. Adverse conditions, which often prevail in the recycling process, are easily absorbed by the gearbox. The robust R3 planetary gear drives impress with an extremely favorable torque/size ratio and run perfectly even at low speeds. Fast speed changes are no problem for the compact yet extremely powerful R3 gearboxes.



The product configuration is highly flexible, due to several options for mounting, gear layout, output shaft and motor interface. According to the torque need and customer machine layout, R3 series can be equipped with 1, 2 or 4 hydraulic motor adapters. Electric motor adapter is also available upon request.

Bonfiglioli planetary drives are the ideal choice for harsh operating conditions. This is especially true for applications in which load peaks occur frequently. Their planetary drives are able to exploit their fundamental strengths in comparison to other types of drives: Their constructive design ensures load distribution, protects the bearings and extends the service life.

www.bonfiglioli.com

ETEL'S Motion Controller

OFFERS REAL-TIME PROCESSING FOR COMPLEX MANUFACTURING APPLICATIONS

ETEL's new UltimET Advanced is a powerful and versatile multi-axis motion controller now available to bring fast real-time processing and a higher level of flexibility to a variety of complex manufacturing applications. This standalone controller from ETEL, a Heidenhain company, is perfect for high-level machine processes in the electronics and automation industries, and of special note in front- and back-end semiconductor manufacturing operations.

As motion control architecture has increased in complexity including the larger amounts of data processing required, so has this expansion of the ETEL motion controller line. With its embedded real-time operating system, quad-core processor, and proprietary algorithms, the UltimET Advanced's architecture has been expanded to meet this challenge.

For example, many front- and back-end semiconductor applications require precise control of movements with multiple axes and powerful controllers to make on-the-fly calculations, correct motion trajectories, and must compensate for environmental factors that affect overall system accuracy. Typically, these types of tasks are handled by the host PC which executes the code before sending data back to the controller. This creates limitations in speed and code size. The UltimET Advanced is a standalone "box format" motion controller with an embedded real-time operating system that allows it to both compile and execute a customer's code, which reduces latency and frees up the PC's resources. This is accomplished through its quad-core processor which dedicates one of its cores to customer processes





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and computations.

The UltimET Advanced allows for incredibly fast, multi-axis motions with the high bandwidth that ETEL AccurET line of controllers typically provide along with TransnET's 1ns communication synchronization, delivering best-in-class motion trajectory performance. Along with computation speed, the architecture allows for easy integration of analog and digital external sensor data into the control loop which provides real-time motion system performance monitoring and critical data logging. All of this ensures the machine's reliability over its lifetime.

Other features include a free development environment (so that the customer's code is not IP dependent) and extended interfacing capabilities such as PCIe and TCP/IP. To make the most out of these features, ETEL offers a consulting service to ensure that a customer's machine can reach its highest potential in performance that the UltimET Advanced was designed to offer.

www.heidenhain.us

Gates

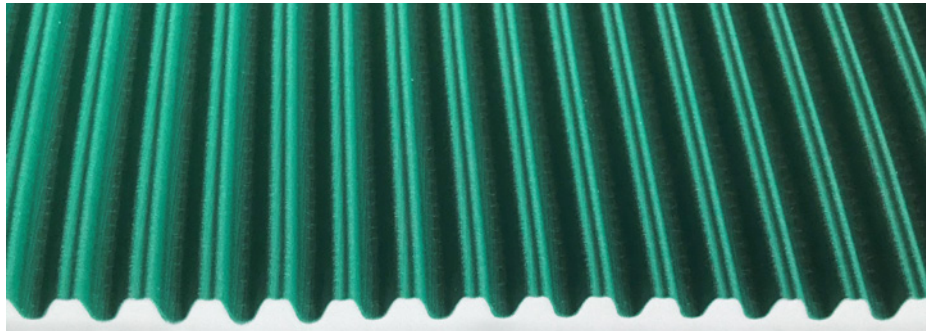
EXPANDS TPU BELT SERIES

Gates has announced the introduction of two new thermoplastic polyurethane (TPU) belts, the Gates Parabolic Pitch (GPP) in 8mm and 14mm profiles. The new GPP belts are stronger, more durable, quieter, safer to operate and require less maintenance than other alternatives, including alternative rubber belts, roller chains and steel cables.

"At Gates, we're continually in search of market opportunities where our materials science expertise and drive to innovate can create added value for

our customers. The new GPP belts are the latest examples of our efforts," said Scott Manley, general manager, Gates TPU. "In addition to expanding our TPU product range, GPP is another example of our commitment to replace legacy technologies with engineered belt solutions that are more efficient, lighter, cleaner, safer and quieter to operate than traditional roller chains, and last up to five times longer than steel cables."

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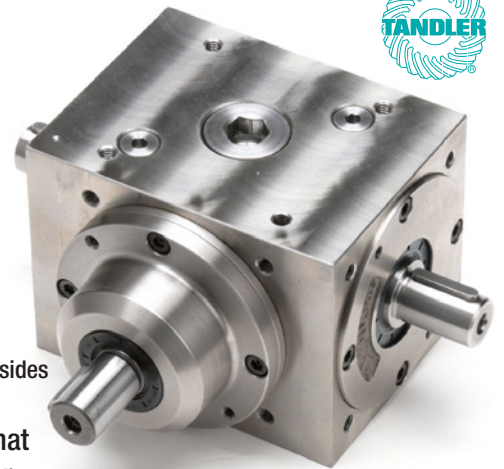
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petition, the high-strength, reinforced steel (RSL) GPP 14-RSL has the highest break strength of any 14 mm pitch TPU belt on the market, and the standard product versions are compatible with Timken's RPP sprockets, making them suitable drop-in replacements across a wide range of applications. All Gates GPP belts are equipped with nylon fabric on the tooth sides for high abrasion resistance and quieter operation, and the optional low-temperature construction provides an operating range from minus 30 degrees up to 50 degrees Celsius. GPP belts complement Gates' existing TPU belt line-up and provide reliable, precision operation across a wide range of industrial applications, including intralogistics, material handling, vertical lift, door opening and industrial automation.

GPP belts are currently available in the North America and EMEA regions.

www.gates.com/TPU

Robotics and industrial automation industries are facing design and production challenges with the urgent need for premium quality parts and services. Stock Drive Products/Sterling Instrument (SDP/SI) is launch-

ing a series of Integrated Motors to simplify motion system design.

Replacing multiple components with a compact all-in-one motor and electronics package, Integrated Motors



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simplify motion system design while providing many advantages.

“Doing speed, position and torque closed-loop control with separate brushless motor and driver/controller technologies can be challenging,” said Jacques Lemire, business unit director, Motors & Motion Control. “Our integrated motor controllers provide easier set-up, smaller and cleaner motion control solutions. By keeping the wiring from the motor to the driver short, integrated motor controllers are the perfect solution for reducing the communication time for the signals from the drivers to the motors.”

SDP/SI products are available with a wide range of standard features for easy integration intended for industrial automation applications. The Integrated Motor Controllers include state-of-the-art brushless servo motors with 4096 lines encoder and CANOpen network protocols in an intelligent plug-and-play package. The high-performance 60 mm NR5-LD60M series incorporates motor, encoder, and drive with smooth and quiet sinusoidal commutation with Field Oriented Control (Vector Control) into a compact unit. The NEMA 23 NH5-DM series is an economical turn-key solution to speed and torque analog motion control. With the elimination of multiple components, connectors, cabling, and labor a significant cost savings is realized.

To cover any system requirements SDP/SI offers DC Motors, AGV Gear Motors and a wide range of AGV accessories including optical flow sensor, magnetic track following sensor, and controller network communication options.

www.sdp-si.com

Dana

INTRODUCES SPICER HVT1 TRANSMISSION

Dana Incorporated has announced the Spicer HVT1, an advanced powersplit transmission that enables the superior performance and sustainability of agriculture telehandlers.

The Spicer HVT1 supports power inputs from 110 to 155 horsepower (80 to 115 kW) and offers fuel savings of up to 30 percent when compared with agriculture telehandlers that use conventional transmissions.

“Buyers of agriculture telehandlers are looking to maximize the value of their investments through equipment that provides efficiency, versatility, sustainability, and power to get the work done,” said Aziz Aghili, executive vice president and president of Heavy Vehicle for Dana Incorporated. “The Spicer HVT1 has been engineered to deliver the superior performance and exceptional long-term value that equipment owners demand.”

Currently undergoing field tests with several global original-equipment manufacturers, the Spicer HVT1 leverages more than a decade of Dana expertise in developing hydromechanical variable transmissions for the off-highway market. Dana already produces market-ready HVTs for construction, agriculture, material handling, and forestry applications.

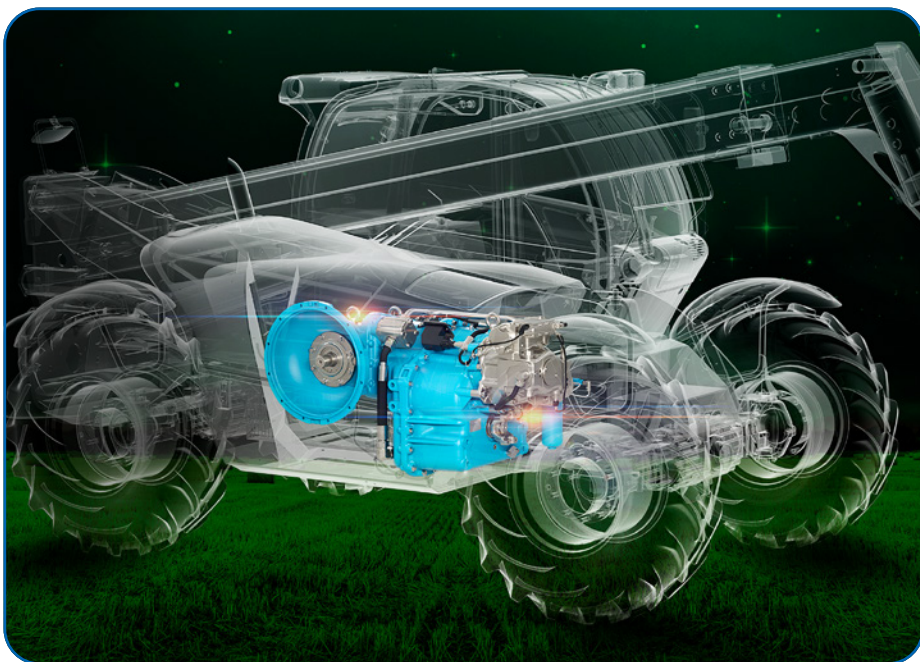
It supplies significant advantages across the board over existing competitive conventional transmissions, helping next-generation telehandlers achieve new levels of productivity, performance, control, refinement, fuel efficiency, ease of use, and operator comfort.

Performance in Every Duty Cycle

The unique design of the Spicer HVT1 provides numerous benefits that address the expanded performance expectations of agriculture telehandlers operating in the farmyard, field, and road.

Its distinctive combination of hydrostatic and mechanical drives in an integrated 90-degree gearbox offers exceptionally precise low-speed maneuvering control and smooth, progressive response for loading and handling cycles. It also delivers superior climbing and high-speed towing capabilities up to 31 mph (50 km/h).

It allows agriculture equipment buyers to increase the utilization of telehandlers by supplying maximum torque for a wide range of rigorous work demands, such as digging and loading.





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To maximize machine productivity in widely varying duty cycles, the Spicer HVT1 uses an advanced electronic control system to continually adjust the mix of hydrostatic and mechanical power, allowing the engine to maintain a consistent speed in its most efficient operating range. It is compliant with ISO standards that govern the safety of control systems for earth-moving machinery, tractors, and other agriculture and forestry machinery.

www.dana.com

KISSsoft

OFFERS CROSSED HELICAL GEAR CALCULATIONS

The gear calculation in KISSsoft covers all common gear types such as cylindrical, bevel, hypoid, worm, beveloid, crown and crossed helical gears.



In the KISSsoft Release 2021, new graphics for the crossed helical gear calculation are available: The evaluation graphic for specific sliding is calculated and displayed based on the geometry of a spur replacement cylindrical gear. A visual evaluation of the tooth meshing in 2D is now also possible for axis crossing angles not equal to 90°. For this purpose, parallel sections to the center axis plane of the worm are calculated and shown. This 2D geometry is visualized using the “Tooth meshing in slices” function.

The option “Determine form diameter dFf and dFa from tooth form” is also selectable.

With the help of the fine sizing method in KISSsoft, you can also find the best variants with preset, definable helical gear stages with preset, definable boundary conditions. If you input the nominal ratio, normal module, pressure angle, helix angle, center distance and profile shift coefficient, the system calculates and displays all the possible suggestions.

All the variants the system finds are then output in a list, classified by the most varied criteria (accuracy of ratio, contact ratio, safety factors, weight, axial forces etc.). You can either expand or reduce the scope of the list, if you want to display more or fewer individual results for a specific solution.

www.kisssoft.com

Regal

ENHANCES ITS POWERTRAIN CAPABILITIES

Regal Beloit Corporation is continuing to enhance its industrial powertrain capabilities. Regal is now even better positioned to maximize uptime and reduce energy consumption in customers’ powertrain applications, whether for new builds or existing installations.

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

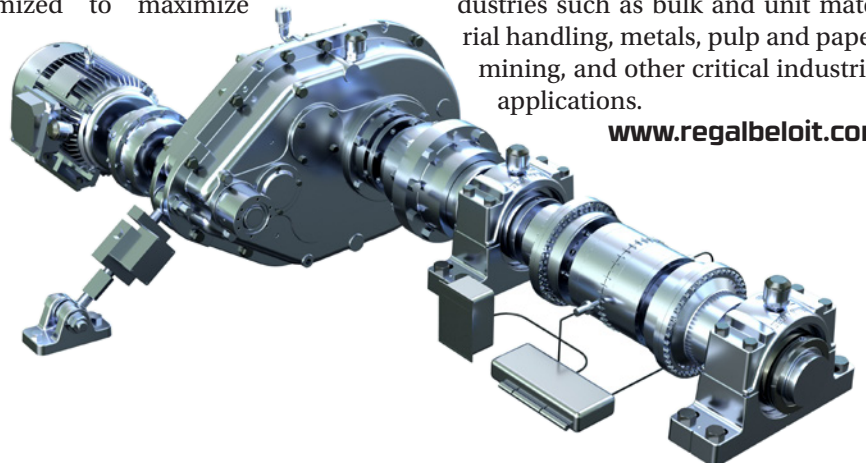
energy efficiency and productivity. In addition to helping customers design, assemble and commission their powertrains, Regal can monitor a solution’s ongoing performance through its cloud-based Perceptiv internet of things (IoT) platform. Data collected and analyzed via Perceptiv can support a wide range of diagnostic and prognostic activities, enabling customers to sustain high performance from their assets.

“At Regal, we create a better tomorrow and endless potential for our customers by energy-efficiently converting power into motion,” said Louis Pinkham, Regal’s chief executive officer. “We optimize our engineered mechanical power transmission components and motors to work better together, more efficiently and effectively. The ongoing asset monitoring we offer across the powertrain with Perceptiv intelligence helps to maximize uptime and prevent costly outages, while simplifying the maintenance, repair and operations experience for our customers.”

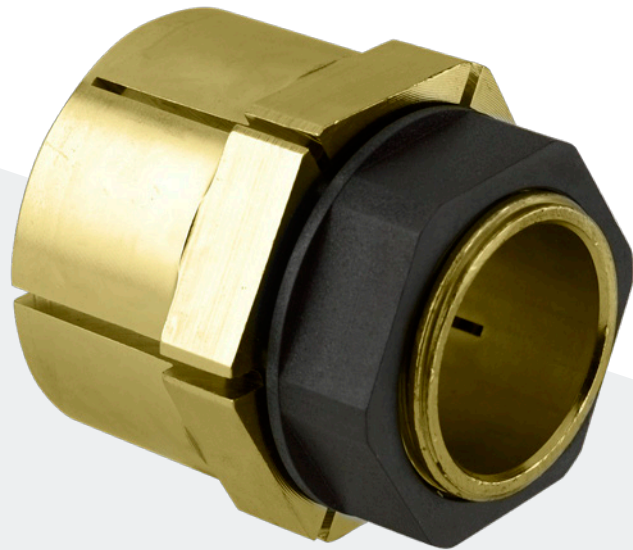
Pinkham continued, “Earlier this year, Regal announced a transformational merger with Rexnord’s Process & Motion Control business, which is on track to close in the fourth quarter. The merger is expected to further enhance our capabilities across the industrial powertrain, especially in higher-torque applications, where Rexnord is strong, while deepening our presence in attractive high-growth end markets such as renewable energy, aerospace and e-commerce, and in a broader set of geographies.”

Currently, Regal’s electromechanical powertrains are used within industries such as bulk and unit material handling, metals, pulp and paper, mining, and other critical industrial applications.

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Think Big, Build Small

Sulzer's processing technologies enable effective small-scale bioplastic manufacturing

Sulzer Chemtech

The demand for sustainable bioplastics is booming, offering unique opportunities to manufacturers entering this market. Small-scale facilities are ideal for new players in the industry as they represent low capital investments with quick returns. When a business in China wanted to develop one of the first fully integrated sugar-to-PLA (polylactic acid) plants in the country, Sulzer delivered a customized project. This allowed the manufacturer to swiftly begin producing 30,000 tonnes of recyclable, compostable and biodegradable polylactic acid (PLA) bioplastic annually.

Sustainable bioplastics can help to realize a circular economy that eliminates waste and reduces the continual use of limited resources. One of the most common and promising bio-based products is PLA, which can be obtained from sugar-rich crops, such as corn and cassava. More precisely, these are used to produce lactic acid and raw lactide, which are then purified and polymerized to obtain high-quality plastics.

By using renewable, biological feedstocks, PLA avoids depleting finite natural resources. The material is also fully recyclable, creating closed loops in which raw materials retain their value as far as possible. Furthermore, its biodegradability prevents the accumulation of waste in the environment, addressing plastic pollution issues.

Thanks to these characteristics, the demand for innovative sustainable bioplastics, such as PLA, has skyrocketed in recent years with the global market size expected to register a double-digit compound annual growth rate (CAGR) of 16% from 2020 to 2027. The expansion of this sector is also shaping manufacturing activities in China, the world's leading producer of plastic,



which is responsible for 31% of the global production of plastic materials.

Businesses interested in manufacturing PLA bioplastics and entering this growing market can benefit from a product with applications in a wide range of industries. To quickly enter this sector, while minimizing any capital risk, small-scale facilities and infrastructures are ideal. Moreover, these can be built closer to where raw materials are sourced, supporting the creation of localized manufacturing and supply centers.

When good things come in small... plants!

These are some of the reasons why a company interested in building one of the first fully-integrated sugar-to-PLA plants in China took this approach. To quickly create an infrastructure with an annual PLA capacity of 30,000 tonnes, the company selected Sulzer as its partner. With over 25 years of experience in lactic acid and PLA-related processes, Sulzer was responsible for the design, basic engineering packages, supply, commissioning and start-up.

The customer appreciated Sulzer's ability to provide a comprehensive solution for the purification of crude lactide, polymerization into high-quality PLA and downstream processing. In addition to the creation of a commercial small-scale plant, the producer was interested in setting up a flexible and scalable system that could provide high-quality materials at a competitive price for a wide range of downstream applications, including food packaging and textiles.

Optimizing capital investments

To address these requirements, Sulzer proposed both stick-build or skid-mounted, modular, fully-integrated design. This comprised distillation and crystallization units, static mixer reactors (SMRs) for polymerization as well as degassing (devolatilization) and pelletizing technologies. More precisely, the combination of distillation and crystallization methods allowed the manufacturer to achieve high purity levels while preserving the chemical, physical and mechanical properties of

lactide as well as optimizing energy usage.

The use of Sulzer's SMRs, created a highly homogeneous melt to obtain high-quality, consistent polymer products while cutting the volume of waste and off-spec materials. Moreover, as they do not have any moving parts, the SMRs consume less energy and require less maintenance than alternative solutions, considerably reducing operational expenses.

The system design also supported the mixing of additives in the melt for pre-compounding PLA prior to the pelletization stage. This further lowered energy utilization and reduced the risk of thermal degradation while limiting the number of processing units on the line, minimizing capital and operational expenses.

Sulzer collaborated with MAAG Group, which provided its specialist, state-of-the-art vacorex x⁶ class extraction gear pump technology for the polymerization and devolatilization stages. In the degassing units, the melt pumps were used to create the necessary pressure to process the melt through the downstream equipment up to the underwater pelletizer.

In addition to fulfilling the key system requirements, MAAG Group's technology helped Sulzer and therefore the customer to further reduce energy consumption and carbon dioxide emissions. As a result, the plant could leverage an

extremely sustainable setup to produce PLA bioplastic.

The power of a leading technology partner

In less than two years, Sulzer's specialized teams were able to complete the entire project from design to the start-up of the crude lactide to PLA and downstream line. One of the main advantages of the partnership with Sulzer reported by the Chinese company was the ability of the process technology specialist to act as a full-service provider and take care of the entire project, allowing the manufacturer to focus on other areas of its business. This streamlined the development of a highly effective fully integrated PLA plant and enabled the company to quickly enter the bioplastic market.

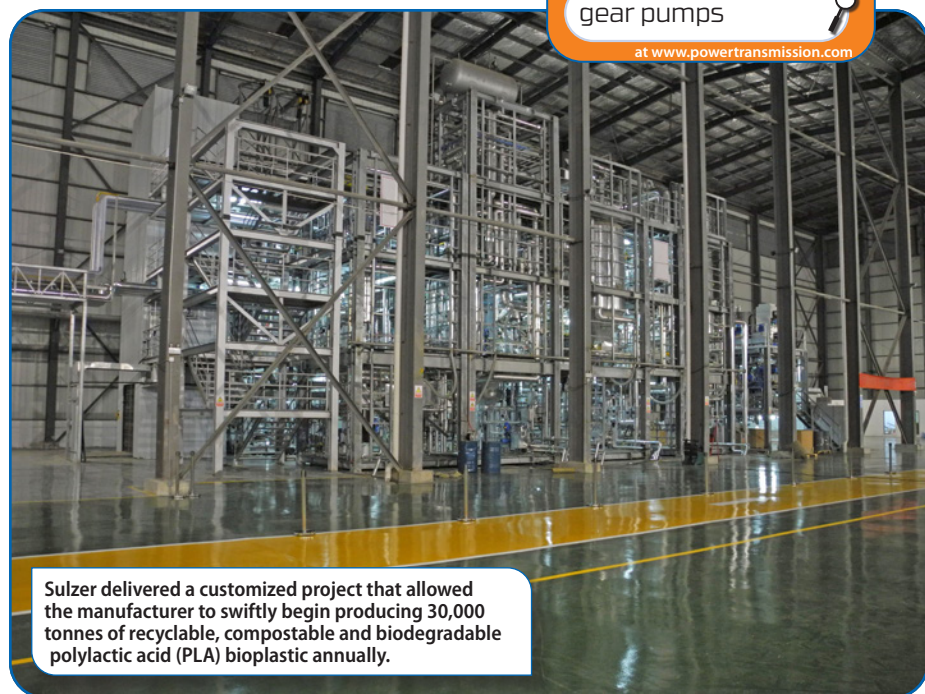
While the current setup allows the PLA manufacturer to produce 30,000 tonnes of bioplastic per year, the modular system that was developed by Sulzer can be easily scaled-up, supporting future expansion projects. As a result, the bioplastic manufacturer can adapt to future market demands and grow its business effectively as well as sustainably. **PTE**

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Sulzer delivered a customized project that allowed the manufacturer to swiftly begin producing 30,000 tonnes of recyclable, compostable and biodegradable polylactic acid (PLA) bioplastic annually.

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Preventing Critical Downtime

Belt and Chain Providers Focus on Quality and Longevity

Matthew Jaster, Senior Editor

“Keep the line moving.” If the production line shuts down due to a faulty belt drive or roller chain in a packaging, food & beverage or industrial application, the situation can escalate rather quickly. Designers of power transmission components today need to look at the ‘big picture’ when creating new products and technologies.

This means examining everything from the raw materials to the hazardous environments these components may be working in. It also means predictive maintenance, sustainability and real-time data analysis will be necessary to prevent downtime. And putting in the extra work to really know the application prior to installation might save a company thousands of dollars.

Organizations like Fenner, Gates and Iwis provide components for power transmission applications. Each company has a sweet spot—so to speak—and the ability to enhance the longevity and quality of their products through field research and material testing.

Fenner Improves Material and Wear Characteristics in Power Transmission Belts

The key to belt drive efficiency and longevity starts at the design phase.

“There are so many variables that go into a V-belt drive including strength, flexural capacity, etc. it’s ideal to be involved in the product design from the very beginning of the application,” said Chris Ward, senior application engineer at Fenner Drives.

Preventing downtime is critical, according to Derek Forney, senior product manager, belting at Fenner. “In our post-pandemic world, the supply chain is full of various obstacles and challenges. The more reliable a product you can provide to a customer, the better the overall experience,” Forney said.

So, what are some of the most common causes of belt failure today? Ward noted slipping due to tension, misalignment, temperature fluctuations and the



Distribution roller drive application utilizing Fenner Poly-V Belts (photo courtesy of Fenner).

environmental conditions of the application. Many of these factors are either overlooked and/or ignored and the equipment is compromised.

“The high-performance properties of polyurethanes in our belts offers customers an aggressive resistance to dust and particulates found in many applications,” Ward added. “These contaminants can have a significant impact on the belts as well as the pulleys.”

Ward said belts that are not well-maintained or not installed correctly will be significantly less predictable with regards to longevity of the drive, causing failures and breakdowns at production critical moments.

Fenner, in fact, recently did a study with a major e-commerce organization on one of Fenner’s conveying products. “The company replaced a rubber V-belt on a roller drive application with a Fenner link belt,” Ward said. “They had to change the rubber V-belt every three months, a process which typically took a couple of hours. They could not afford belt failures in the middle of large shipping runs. By upgrading to a Fenner link belt, the company saw belt life increase 18+ months, and it only took 15-minutes to change

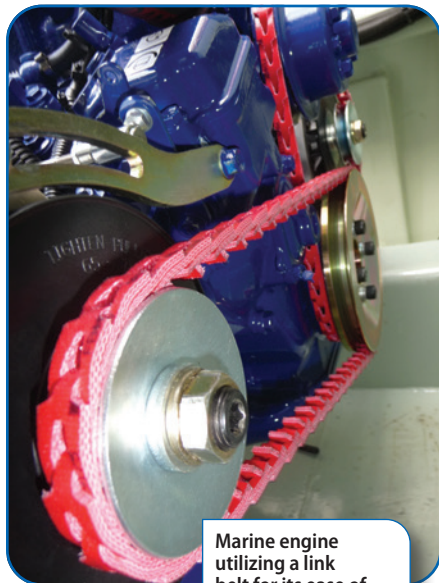
the belts.”

While these belting products have been around for a very long time, Fenner engineers continue to evaluate different materials to improve belt characteristics. “The understanding of the polymers and the chemistry that goes into these belts is the foundation of our product design,” Forney said.

Another area of interest pertains to Fenner’s spring-loaded tensioners. Ward said that many OEMs are so comfortable with V-belts that they would rather stick with a product they know than replace it with an alternative, even if the alternative can save time and money.

“There are some people that love the rubber V-belt, but unfortunately you cannot get away from that product stretching over time, so we have a range of spring-loaded tensioners that a lot of our guys will use with the V-belts,” Ward said. “If they would rather stay with what they know, this is another option.”

Although the organization is a year or two away from announcements on new belt technology, both Ward and Forney hint at a future where testing and modeling will provide an even



Marine engine utilizing a link belt for its ease of installation (photo courtesy of Fenner).

clearer path toward belt selection for a particular application.

“We’re always looking at next generation products, playing with the different materials and designs - asking all the right questions. How can we improve our product design to stay ahead in these industrial markets?” Ward added.

This involves setting parameters and goals that the engineering team would like to achieve by creating new material properties, cutting some belts and putting them on a test rig for three months to obtain results. “It can be a laborious process,” said Ward, “What we’re trying to do today is design a belt that fits a certain application and can be evaluated and tested faster and more efficiently to provide the data we need.”

Problem-solving on an application-by-application basis is what Fenner does best. “I see maintenance guys use their thumb to check belt tension, that’s it, just a thumb on the belt. We have equipment that can provide a greater understanding of belt tension, misalignment, improper installation, etc., they need to be willing to look at all these factors from the very beginning,” Ward said.

From a holistic perspective, the objective for Fenner becomes more about sustainability.

“How can we become more sustainable both in the life of products and our raw materials? There’s technology coming that will definitely help a

customer select the right belt for the right application,” Forney said. “We’ll have some exciting new things to share in this area soon.”

www.fennerdrives.com

Gates Taps Scientists and Engineers for Belt Technology

The big culprits of belt failure are poor drive design, incorrect installation, and improper maintenance, according to Lucas Dillon, product manager, V-belts at Gates Corporation. Each of these fac-

tors can eventually lead to excessive wear of the belt, pulley/sprocket, or both, greatly reducing the life of a belt.

“It starts before the drive is ever installed, by ensuring it isn’t over or under designed and that the proper belt is chosen for the application,” Dillon said. “Once designed, drives need to be properly aligned and the correct belts installed at the proper tension. After installing, periodic drive inspections should be performed to check for worn pulleys or sprockets,



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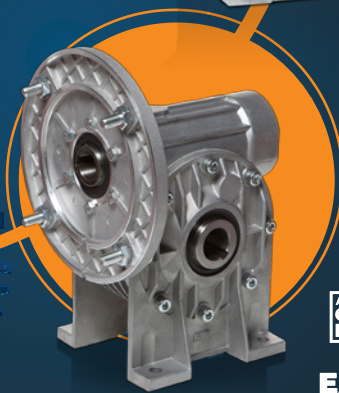
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Synchronous belts require no maintenance when correctly aligned and tensioned and will run efficiently until they're ready to be replaced (photo courtesy of Gates).

misalignment, proper tension, and belt wear or damage."

Dillon said belts are used in critical production line equipment. "If there's a failure on any one piece, it's likely to put the entire line down. With the speed and efficiency of today's production lines, you could be looking at thousands of units per minute in productivity loss," he added.

Therefore, the development and testing of new production methods and materials is imperative to handle the diverse range of applications where a belt might be used.

"One example would be our proprietary ethylene elastomer compounds being used in our newer products that's able to handle wider temperature ranges, more load capacity, and provide longer belt life," Dillon said.

Sensors and IoT solutions can have a huge role in analyzing belts in these applications.

"Consider a sensor on a piece of equipment that sends a notification in real time that a belt is slipping on the driven side and likely to fail soon," Dillon said. "Being able to identify those types of things in advance will prevent failure and fend off the dreaded downtime that was mentioned earlier."

Advancements in technology have increased the productivity of the V-belt despite it being invented more than 100 years ago. Dillon said there are







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belts in the market today that are essentially maintenance free after installation. Synchronous belts require no maintenance when correctly aligned and tensioned and will run efficiently until they're ready to be replaced.

Once the right belt is selected for a particular application, it's up to the maintenance team to utilize a no-nonsense approach to preventative maintenance.

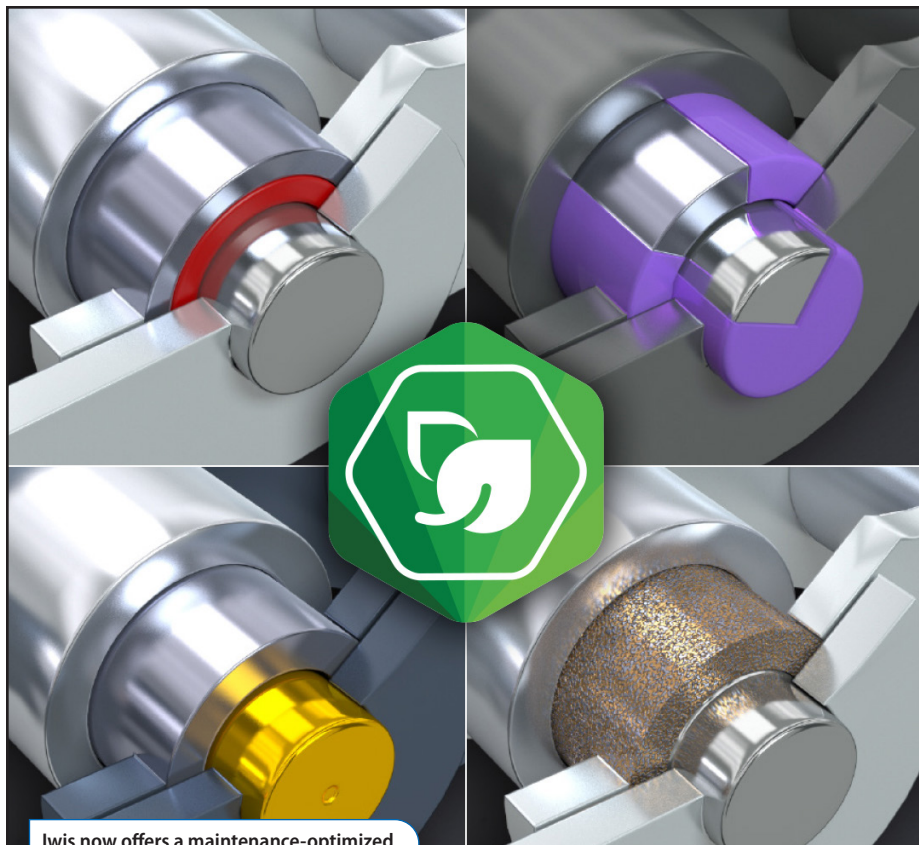
"Although some belts are entirely maintenance free after installation, as is the case with synchronous, drive components like sheaves and sprockets should be checked periodically for wear as that can quickly lead to belt failure," Dillon said.

According to Dillon, efficiency relies on a smoothly running belt, which will only happen with a properly maintained drive.

"As alluded to earlier, downtime is another costly consequence of neglecting a solid maintenance plan. Time is money and that rings especially true on the production line. A good rule of thumb is that it takes three times as long to install a new belt drive as it does to re-tension a belt that is currently installed," he added.

In order to increase the reliability of belts in operation, Dillon suggests customers should work with an expert to make sure the drive is designed properly for the application. Gates offers free product application support

The heavy-duty belt construction is designed to handle high horsepower motors, frequent shock loads, high heat, and the harshest operating environments in extremely demanding applications (photo courtesy of Gates).



Iwis now offers a maintenance-optimized chain program (photo courtesy of Iwis).

alongside its sales and engineering teams, which is an invaluable resource that will go a long way towards a reliable power transmission drive.

"There are several offerings that are designed for specific applications and product application engineers are in the best position to help you identify what will work best. Their guidance can work hand-in-hand with our drive design software tools to help assure a proper belt drive design," Dillon said.

Dillon said one of the key technologies in belt technology today is the use of Ethylene Elastomers in high-performing belts. "When combined with new cord and tooth fabric developments, it delivers higher horsepower capacity and temperature range, while remaining static-conductive and being more environmentally friendly."

www.gates.com

Iwis Goes Maintenance-Free with Environmentally Friendly Chains

Iwis opened a new, green chapter in the company's history this year with its maintenance-optimized chain program: Low-maintenance and maintenance-free chains make a valuable contribution to environmentally friendly and sustainable operations in machine and plant engineering - and are highly efficient at the same time.

Regular maintenance is a basic requirement for reduced wear and a longer service life of chains - and lubricant is essential here as well. But wherever lubricant is not desired or relubrication is hardly or not possible, the resulting friction can also be reduced by special joint designs and the service life of the chain can be significantly extended. Maintenance-optimized chains from Iwis extend the service life of roller chains and at the same time save lubricants, require less energy and thus reduce the consumption of fossil fuels.

The term "maintenance-free" is not firmly defined and is interpreted in

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very different ways. There is a wide range of possibilities for increasing the service life of chains by means of special joint designs. Depending on the resulting performance, Iwis differentiates between low-maintenance and maintenance-free solutions for chains with optimized maintenance characteristics (both approaches aim to protect natural resources).

MEGAlife roller chains and CF-b. dry stainless steel chains are equipped with a special joint design. This results in less friction. In addition, the surfaces of the individual parts can be treated with special methods. This results in maintenance-free chains that can be operated for a longer period of time without relubrication.

The Iwis b.triton roller chains and low-maintenance Super-Longlife roller chains achieve an increased wear life through selected surface treatments on the individual parts. With low-maintenance chains, the relubrication intervals of conventional standard roller chains are considerably extended.

www.iwis.com.

A Future Built on In-Depth Analysis

Condition monitoring will continue to play a huge role in the future of belts and chains. These technologies will determine how organizations will get the most out of their machines and systems. Early warning systems and maintenance packages will be able to provide real-time data so that the appropriate action can be taken in a timely fashion.

While temperature changes, misalignments and improper installations can result in costly production interruptions, the future will put an emphasis on planned maintenance schedules and give maintenance teams an intelligent, timely report on the status of the system as well as its components. These technologies will no doubt increase machine utilization and productivity for years to come. **PTE**

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U.S. Tsubaki

Chain Wear Indicator Kit

Detecting and measuring chain wear elongation is critical for achieving reliable operation of industrial chains. Although it is common for users to employ a tape measure or ruler, it is more effective to use a specialized tool to determine whether the chain requires replacement.

Causes of Industrial Roller Chain Wear

Despite common misconceptions, chains do not physically stretch over time when used at rated loads. Roller chain elongation occurs as the material wears away at the chain's pins and bushings, creating more space between these components. This wear can occur due to many factors, such as:

- Insufficient chain lubrication
- Poor maintenance
- High-speed operations
- Frequent heavy loads
- Extreme temperatures
- Exposure to abrasive environments

Measuring Chain Wear

Understanding how to properly measure chain wear elongation will help to proactively ensure optimum performance. When left unchecked, chain wear may eventually result in slippage, poor equipment performance, and unwanted downtime.

Instead of a ruler or tape measure, experts recommend using a specialized measuring tool that provides a more accurate indicator of chain wear. In order to assure measurement accuracy, the chain should be taut. In most industrial roller chain applications, 1.5%-2% is typically considered wear life limit requiring chain replacement. Using our Chain Wear Indicator Tools as part of regular plant maintenance will simplify your chain maintenance operations and keep equipment running optimally.

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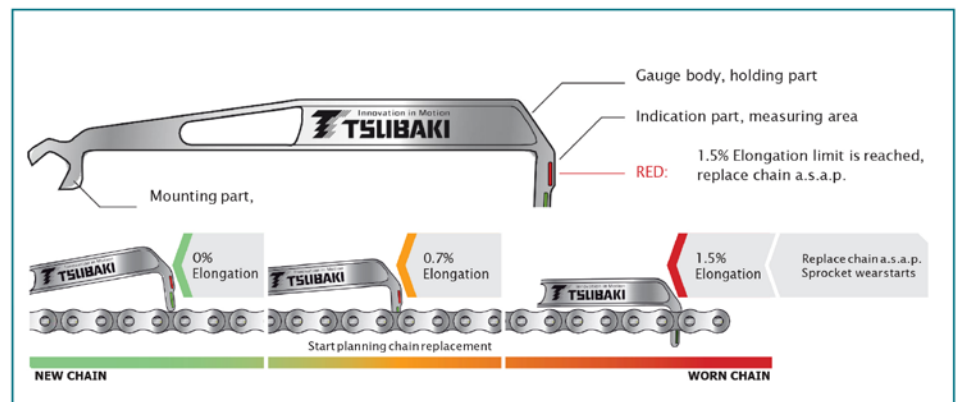
ANSI Standard

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- Roller diameter wear gauge



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Gear Manufacturing in Motion

MPT Expo Highlights Latest and Greatest Innovations

Matthew Jaster, Senior Editor

Electric and fluid power has expanded the focus recently at the Motion+Power Technology Expo—September 14–16, St. Louis, Missouri—but gear manufacturing remains the core of AGMA's biennial trade show. The following is an overview of many of the services and technologies being exhibited by some of the leading gear manufacturers at MPT:

Bevel Gears India Booth # 2420

Bevel Gears India has manufactured and designed bevel gears and bevel gear boxes for over 40 years. With over 75 bevel gear grinding, cutting, testing and lapping machines, customers' bevel gears are manufactured to DIN and AGMA standards using the Gleason and Klingelnberg systems.

Bevel Gears India caters to the requirement of end users of ground spiral bevels, spiral bevels, straight bevels, zerol bevels, angular bevels and hypoids.

Customers are invited to leverage our capabilities, decades of experience, Gleason CAGE prepared summaries, CNC gear testing and production facilities to develop the gearing solutions they need for demanding applications.

www.bevelgearsindia.com

Brelie Gear Co. Booth #3520

Brelie Gear is a full-service gear manufacturer, specializing in fine- and medium-pitch spur and helical gears, worms, worm gears, and worm shafts. The company offers gear crowning and carbide re-hobbing to improve gear quality and reduce gearbox noise. Components are produced using state-of-the-art Koepfer and Mitsubishi hobbing equipment. This equipment, along with ISO 9001 registered systems, allows Brelie to produce gears up to AGMA 12. In addition to its gearing capabilities, Brelie offers complete in-house turning and machining.

www.breliegear.com

Cincinnati Gearing Systems Booth #1907

Founding American Gear Manufacturing Association member, Cincinnati Gearing Systems Inc., (CGS) announces a series of facility improvements and additional machines in response to new contracts and to meet ever increasing demand for precision gear manufacturing and design engineering.

CGS component gears and enclosed drives are manufactured, assembled and tested by a skilled workforce in Cincinnati, OH. CGS products support a variety of applications such as automotive drive gearing, diesel engine gearing, military and commercial marine propulsion, turbine powered generator drives, wind energy, pump drives and expander/compressor drives. CGS is ISO 9001:2015 and IATF 16949:2016 certified.

CGS assembly and test facility improvements include the installation of two 20-ton cranes with 5-ton auxiliary and one 10-ton crane. In the same facility there is a new dedicated full load test cell supported by a 1,500 hp motor.

Within the last two years, Cincinnati Gearing Systems has purchased 7 additional machines:

Kapp-Niles gear grinder offers unique tooling for grinding double helical gears with limited clearance between the gear faces.

Liebherr CNC shaper cutter doubles current cutting speeds and has laser apex alignment, increasing gear quality. This shaper cutter is capable of cutting tapered splines and any helix angle without the need for additional tooling.

Höfler Porta internal and external gear grinder; The OD/ID grinding wheel finish grinds diameters and thrust faces in the same setup as tooth grinding, combining three separate machine operations into one.

Other machines recently installed include a Hyundai horizontal boring mill, Hyundai vertical mill, Hyundai CNC turning center and a Gleason GMS gear analyzer.



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- ID Grinding 0.5"-134"
- Tooth Grinding 16 DP-0.75 DP (2"-130")
- Milling Up to 200"

Improvements to CGS's testing, assembly and manufacturing facilities have significantly increased capacity and production process flow while decreasing lead time. Visit **Booth #1907** at the Motion + Power Technology Expo to see how Cincinnati Gearing Systems' in-house engineering, manufacturing, assembly and testing and heat-treating services can support your future gear and gearbox needs.

www.cincinnatigearingsystems.com

Circle Gear Booth #3429

Circle Gear is a leader in quality custom gearing, specializing in small to medium lot production. They are one of the only companies in the country that will reverse engineer and manufacture spiral bevel gear sets. Circle Gear services include: Bevel Gears (Straight & Spiral up to 36" diameter), Spur Gears, Helical Gears, Herringbones (up to 60" diameter), Internals, Racks, Sprockets, Worm and Worm Gears, to all other types of power transmission products. Circle Gear provides servicing on Splines (involute & straight-sided, internal & external). They offer reverse engineering as well as breakdown services on many products. Circle Gear currently resides in a 125,000 sq. ft. full-service production facility. They house a full-service gearbox rebuild division, QRS, Quality Reducer Service. QRS specializes in rebuilds of all major brands of gear reducers as well as manufacturing of custom designed units.

www.circlegear.com

Columbia Gear Corporation Booth #2230

Columbia Gear Corporation is a premier supplier of custom gearing and power transmission products including precision spur and helical gears, splined gears and shafts and complete gearboxes. They are continually adapting to today's customer needs. Columbia continually analyzes manufacturing processes, builds upon proven design solutions, streamlines production and assembly schedules — always taking ground gearing quality to higher levels. Conveniently located in Central Minnesota, the facility encompasses 235,000 sq. ft. Columbia Gear manufactures gears, shafts and power transmission products for the agricultural, aviation, construction, compressor, locomotive, mining, rail, oil & gas and wind power industries.

www.columbiagear.com

Croix Gear & Machining Booth #2931

The COVID-19 pandemic continues to cause major disruption to supply chains around the world. While a global pandemic is not your typical supply chain event, the root causes of the current supply chain issues are not limited to just pandemic stress. Post-pandemic demand, transportation breakdowns, workforce shortages, and raw material scarcities have further exposed existing supply chain vulnerabilities. Unfortunately, the gear manufacturing supply chain is not immune to these challenges.

In fact, a recent Accenture study on "Supply Chain Disruption" reported that "94% of Fortune 1000 companies are seeing supply chain disruptions from COVID-19" and "75% of companies have had negative or strongly negative impacts on their businesses."



Over the past several months, Croix Gear & Machining has been conducting in-depth conversations with key OEM customers to better understand what they are experiencing and what we can do to combat it. Not surprising, the single most challenge coming out of COVID-19 is that supply chain disruptions are preventing OEMs from fulfilling customer orders, creating inefficiencies on their manufacturing floor, and ultimately putting their business at risk. In addition, the recent trend of offshoring gear manufacturing only exacerbated the problem, in that they failed to establish secondary domestic suppliers as a "safety net." In the near term,

procurement leaders are requesting better information so they can make the quick, better-informed decisions needed to sustain manufacturing operations. In the long-term, they are looking for “outside the box” thinking to improving gear supply chain relationships that can provide resiliency, agility, and reliability.

In the coming weeks, leading up to the 2021 Motion + Power Technology Expo, the company will share more about the best practices they have discovered to help meet these challenges.

To discuss navigating your particular supply chain challenges, be sure to visit the Croix Gear & Machining Team at the Motion + Power Technology Expo **Booth #2931**.

www.croixgear.com

Forest City Gear Booth #2513

Forest City Gear is a family-owned and operated business in the gear manufacturing industry since 1955. They manufacture fine and medium pitch custom gears for a diverse array of industries covering a wide range of applications.

Forest City Gear’s team of experts will be available at Motion + Power Technology Expo to discuss trends, technologies and best practices in gear manufacturing, and to review blueprints and provide on-the-spot manufacturability consultation.



Forest City Gear offers two primary manufacturing options. “Cut Teeth Only” is a cost-effective, quick turn option for customers who provide the gear blank and need gear-cutting only. Lead time is very reasonable, typically 2 weeks or less, assuming a special-order cutter is not required. With an inventory of over 7,000 cutters in stock, Forest City Gear is able to keep lead time as short as possible and to support small lots up to high-volume orders with ease and flexibility.

For customers who need a partner to manufacture gears to their specifications, Forest City Gear offers “Make Complete” services. A dedicated team manages the entire process: ordering the raw materials, turning the blanks, machining (everything from gear cutting to finish grinding), and managing any outside services such as plating or heat treating. Lead times for these orders vary depending on availability of materials and quantity ordered.

Forest City Gear is so well known for their quality to have been selected by NASA to support every Mars Rover project to date, including supplying over 100 gears for the Perseverance rover. The company manufactured gears for every actuator on the vehicle, from the wheel drive systems to the focusing optics. All the gear-driven motion systems

that the rover utilizes to move or to articulate a part of its scientific instruments, including the Sky Crane that worked to lower Perseverance to the surface, are driven by gears from Forest City Gear.

FCG supports gears for aerospace, defense, dental, medical, racing, recreation, robotics, off-highway, offshore and outer space applications and more

www.forestcitygear.com

Gear Motions Booth #2925

The team at Gear Motions is energized and ready to reconnect with the gear industry in person at Motion+Power Technology Expo Booth #2925. Show attendees will get a glimpse into the future as the company introduces some exciting new accomplishments in precision manufacturing.



First, Gear Motions will be sharing the latest details on a brand-new gear manufacturing facility in Buffalo, NY. This world class facility will bring Gear Motions’ two Buffalo divisions, Niagara Gear and Oliver Gear, together under one roof and will provide plenty of manufacturing and office space for the company’s growing and changing needs.

In new equipment and capabilities, Gear Motions recently added a trio of ultramodern gear grinding systems from Reishauer; two model RZ260s, and one RZ550, all equipped with advanced robotic automation systems from Felsomat. These high-performance grinders, paired with multi-pallet automation, have greatly improved gear grinding performance and efficiency. New capabilities include super finishing and polish grinding on parts ranging in size from 0.5 to 27.5 inches in diameter and accommodating a variety of part types including spur gears, helical gears, and assemblies.

In product news, past attendees of MPT Expo may remember that in 2019 Gear Motions introduced Kinatech, the groundbreaking non-backdriveable gearbox technology. The organization will not only be demonstrating the next generation gearbox at MPT 2021, but will also be ready to start taking orders.

What has not changed at Gear Motions is its knowledgeable, experienced team of employee owners who will be available at the show to do what they do best; work with you to solve problems and meet your gear manufacturing needs.

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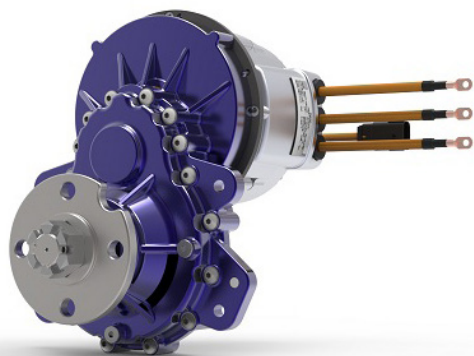
In the middle of the hustle and bustle of the show floor, they will have a dedicated meeting space in the booth for in-person discussion, dive into customer challenges, and offer solutions.

Gear Motions is a leading gear manufacturer specializing in supplying custom cut and ground gears for OEMs all around the world. Kinatech is a new mechanical locking system that will hold any load in place without using electricity, pneumatics, hydraulics, friction, or any other external braking system. Learn more here:

garmotions.com.

Omni Gear & Machine Corp. Booth #3536

Omni Gear manufactures power transmission systems for agricultural, off-highway, and industrial equipment manufacturers. They maintain manufacturing and assembly centers around the world to design and distribute enclosed gear drives utilizing straight bevel, spur, spiral bevel, helical and



worm gearing. They began by supplying power transmission equipment for agricultural machinery in 1958. Today, they are a leading manufacturer providing gearboxes, specialty forgings, and custom gears for a variety of industries and applications. Industries include agriculture, on highway, construction, forestry and more.

www.omnipowertrain.com

Philadelphia Gear: Power Systems by Timken Booth #3532

As a part of Timken Power Systems, Philadelphia Gear combines over a century of OEM experience with the expertise of six other leading service providers to deliver complete electromechanical support from a single trusted source. So whether it's gears grinding to a halt, burned-out motors, worn out bearings, or malfunctioning controllers, you get every result you need — all from one name.

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and open gearing; electric motor and generator replacement parts; onsite technical services for gearboxes, electric motors, generators, and bearings and more.

Philagear.com

Rave Gears Booth #2416

Rave Gears and Machining is committed to providing high quality, precision CNC machining, prototyping and supply of gears and gear shafts with shared customer focus on meeting delivery commitments through transparency and trust. The company believes in employee development, investment in advanced technology and continuous improvement. They offer CNC milling and machining centers, CNC turning, CNC turn/mill centers for spiral bevel and Zerol bevel gears.

ravegears.com.

Schafer Industries Booth #2507

For more than 85 years, Schafer has solved some of the toughest challenges with its custom-engineered gear and driveline solutions. Working with Schafer Gear Works, Schafer Aerospace or Schafer Driveline, customers can build better performance, greater cost-savings and higher satisfaction into your products. This is why Schafer's gear and driveline innovations power some of the most respected products and vehicles in the world. It's why companies in an ever-expanding list of industries from aerospace to underground mining turn to Schafer's engineers and manufacturing teams to help them stand out from their competition. ISO 9001:2015 and AS9100:2016 certification combined with lean cell-based manufacturing processes ensure you of strict compliance to quality and delivery standards. From in-house engineering support teams to on-the-line machine operators to after-sales customer service, Schafer can listen and respond to your needs. **PTE**

www.schaferindustries.com

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The editors of *Power Transmission Engineering* and *Gear Technology* will be conducting live interviews with the technical experts and product specialists of suppliers in the gear and power transmission industries.



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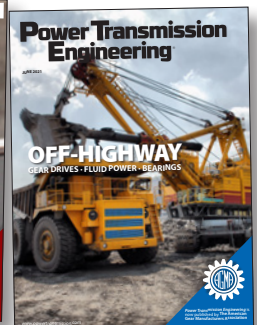
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Avoiding Common Pitfalls When Selecting & Integrating Linear Modules

Justin Lackey, Product Manager – Systems – Bosch Rexroth

Fully integrated linear modules can be versatile and cost-effective for linear transport applications in packaging machinery.

When specifying and integrating pre-engineered linear modules, whether for Cartesian robots, pick-and-place equipment or linear transport systems in or between production lines, following these key tips can help avoid common technical and operational pitfalls.

Size correctly for long-term use.

The most common mistake is sizing linear modules improperly for long-term use. Too often, purchasers will determine the standard speed or load capacity of the system they are building and then select a module whose maximum speed or load is that same number. This leads to undersizing the module, which can result in multiple possibilities for failure. In addition, if the linear module is undersized for the load it's carrying, this may void a manufacturer's warranty.

An opposite mistake is oversizing — selecting a module with much more



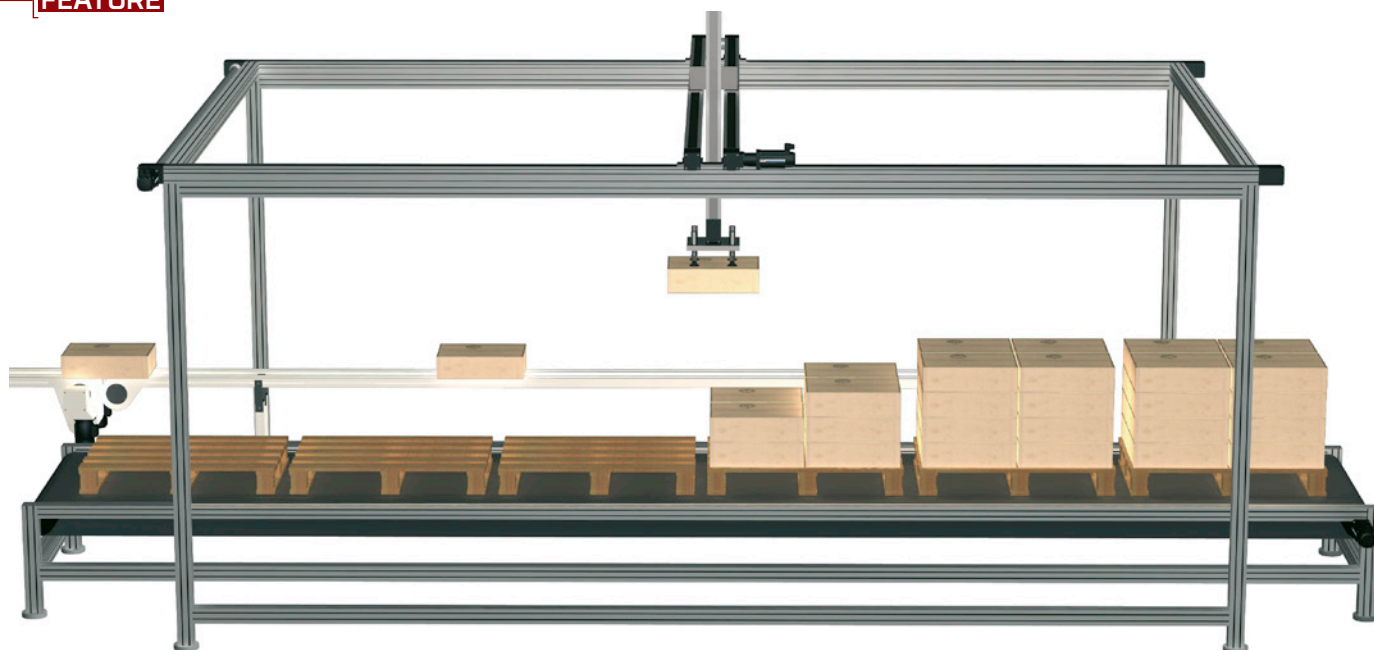
carrying or speed capacity than an application requires. While this can be safer, it's more costly than what's actually needed. Work with a supplier that can provide high-quality, easy-to-use sizing software to ensure the linear module is sized precisely for the application.

Avoid over-specifying performance criteria.

Searching for and selecting linear modules based on overly precise performance criteria can lead to linear modules that are more expensive and complex to work with than necessary. For example, some linear modules are available in both steel and aluminum extrusion housings for the guide into the drive system. The steel housing is much more rigid but also has higher costs. Depending on the load to be carried by the module, aluminum housing may be a better solution.

The two most widely used mechanical drives in linear modules are belt drives and ball screw drives. Ball screw drives work best for applications that require a high degree of endpoint accuracy and repeatability, as well as carrying or moving loads vertically.





If the packaging machine's linear motion requirements do not require high end-point accuracy, belt-driven linear modules can provide a more cost-effective and fully functional solution. For example, the Bosch Rexroth MKR Belt Driven Module features a high-performance, toothed belt for high drive torques, long travel lengths and high rigidity. This type of linear module is available in multiple lengths and has an end-point accuracy of 500 microns, which can satisfy many applications.

Consider linear module mounting and integration into larger machines.

Linear modules are often integrated into larger machines or combined into systems such as pick-and-place Cartesian robots. One item often overlooked is the module connection and mounting. Depending on the supplier, some modules are designed to be mounted only by the base of the extrusion; if the mounting location on the machine doesn't allow for that, additional mounting brackets and other hardware may have to be purchased or machined from scratch, increasing costs and adding time to machine integration.

Be sure to investigate how a linear module will be mounted and evaluate mounting options. In addition, check if features are included to help fit and align modules quickly and accurately into tight machine spaces.

Standardized, positive-locking connection elements with centering technology alleviate the need for expensive, custom-designed construction. Bosch Rexroth linear module components, for example, feature connecting elements, such as brackets, adapter plates, clamping fixtures, sliding blocks, T-nuts, positive-locking centering rings, etc., designed to simplify installation and integration.

Make sure CAD models are included in the package.

Some linear module suppliers don't include complete CAD models as part of the purchase. While that may lower the initial cost, it's usually necessary to create CAD models anyway in order to properly engineer, configure and integrate the final system. If a CAD model isn't included, the OEM or end-user will need to create their own. However, many companies are scaling back engineering departments to control costs, so this additional task can end up slowing down the project. While many linear module manufacturers include CAD models as standard elements, it pays to be certain.

Use linear modules that have been fully tested to ensure proper mounting and alignment.

Incorrect mounting and alignment practices can degrade linear module performance, with components like bearings and belt drives wearing out faster than expected. Work with a

linear module supplier whose products are engineered with centering technology, such as centering holes and slots for connectivity, which helps to ensure that all components are tightly aligned and level as part of the installation process.

It's also important to ask about the type of performance testing a linear supplier conducts on its products. Some suppliers assemble and deliver customers' modules without testing first, leading to specification issues after the install. It's best to work with a supplier that performs a runoff test with torque measurement, verifying that when the linear module is manufactured, it meets all specifications.

Check the linear module design for easy lubrication access points.

Linear modules require regular lubrication. A common pitfall is that linear modules are often installed in packaging machinery where lubrication ports are hard to access. A linear module design should feature multiple lubrication ports, making it easier to integrate into the machine design.

It's also extremely important to follow the manufacturer's guidelines for lubrication. This is typically a very specific type of lubricant — for example, for linear ball bearings, an NLGI lithium soap grease with no solid particles must be used. Many users

apply lubricant with carbonate or other solid particles because they can use it in other parts of the machine. Unfortunately, this can cause wear and premature failure for linear module bearings.

Align the linear module performance characteristics with the motion controller.

Finally, when integrating linear modules on a machine, the motion controller and drive parameters must be programmed with correct, safe torque limits and end-of-stroke limits to ensure the linear module doesn't overshoot its limits or operate with excessive end-point vibration. It's best to confirm the electrical and mechanical engineers on a project clearly understand the established parameters for each linear module. **PTE**

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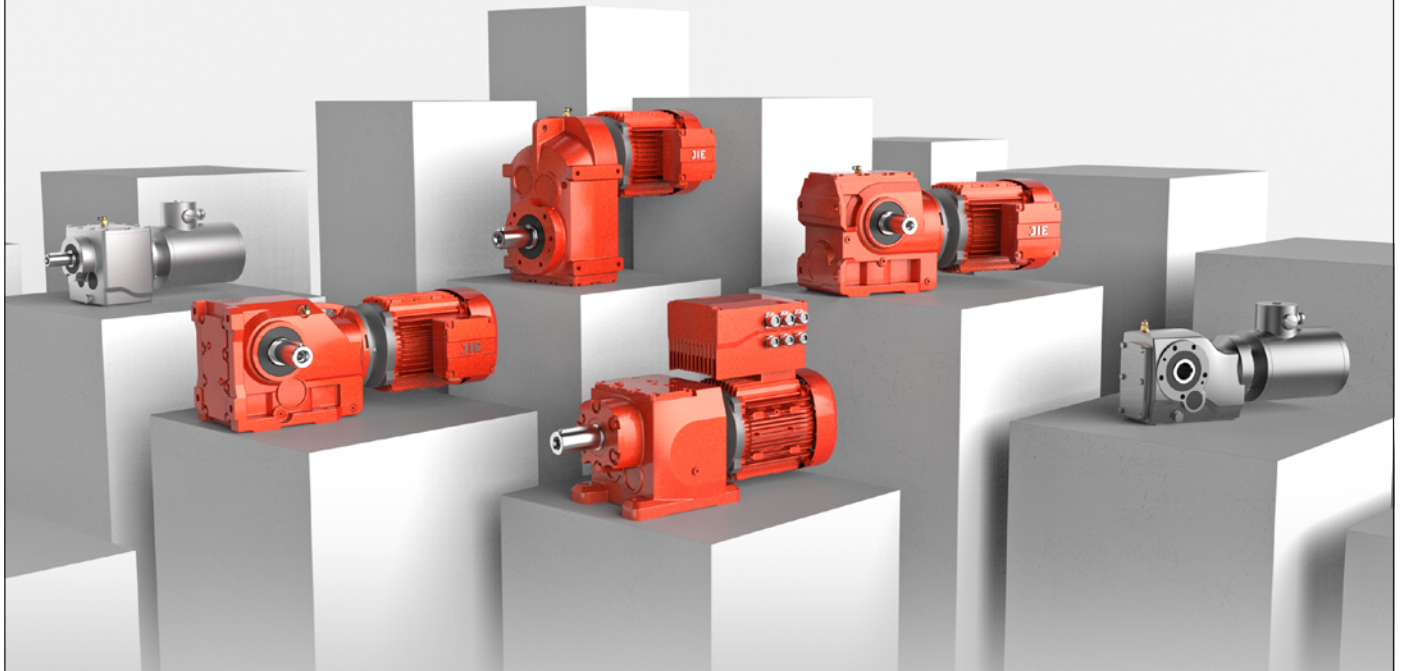
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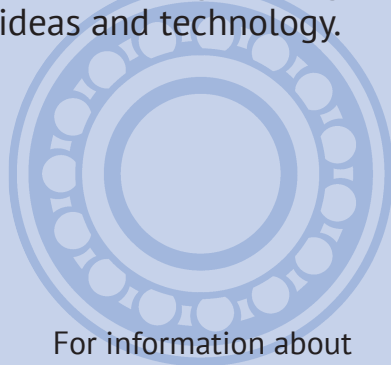
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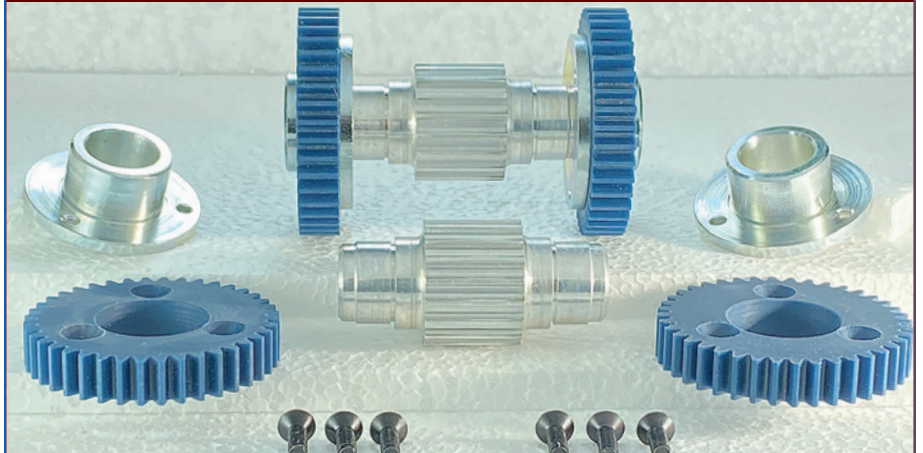


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Low Noise and Transmission Error Epicyclic Gearbox Designs

T. J. Lisle, B. A. Shaw, R. C. Frazer, Y. Yang, L. Zhao

Introduction

Minimizing gear transmission error (TE) and the resulting noise and dynamic load is a subject well researched and understood. Quite simply, changes in tooth load sharing, mesh stiffness, deflections and geometric deviations from the true involute, introduce small oscillatory rotations of the wheel relative to the pinion. Common TE optimization approaches aim to minimize the change in load distribution amongst the teeth, whether by increasing the transverse contact ratio, as is common in high contact ratio (HCR) spur gears, or by introducing an axial overlap ratio by adopting helical gears. Indeed, a superior helical solution maintains an integer overlap ratio (IOR) such that the theoretical load line lengths remain constant, regardless of the transverse contact ratio. Irrespective of the chosen macro geometry, gears are also exposed to loaded deflections and random manufacturing errors, which

further influence the operational transmission error which is often minimized via micro geometry corrections.

With regards to epicyclic gearboxes, whether it be a planetary, star or solar design, there exists another unique feature which can be manipulated to further minimize TE—the phasing of the planets—for which, previous research has shown to have a significant impact on the dynamic characteristics of the gearbox (Refs. 1-10).

An epicyclic gearbox designed such that all the planets enter mesh with the sun at the same time, and all the planets enter mesh with the ring at the same time, is often said to be in-phase or factorizing. This condition is achieved if the number of teeth on the sun, divided by the number of planets establishes an integer value. Alternatively, the system may be designed such that the planets enter and exit mesh at different phases, which is said to be out-of-phase, non-factorizing or sequential. This can be

achieved while still maintaining equal planet spacing, and since the individual engagements are staggered, the total transmission error can be significantly reduced. It is for this reason that a sequential design is believed to be superior for minimizing torsional vibrations and TE, albeit at the expense of possible transverse and rotational vibrations.

Regardless of whether a design is sequential or not, there also exists the phasing between the sun/planet (S/P) to the planet/ring (P/R), which can themselves be either in or out of phase.

The notion of phasing is investigated using commercially available gear analysis software (Dontyne) (Ref. 11) which adopts simple strip theory (Ref. 12) to establish the quasi-static TE. Here, tooth stiffness is assumed parabolic and a maximum at the pitch point, falling to approximately 70% at the start and end of active profile (Ref. 13). Combined with load sharing, micro geometry corrections and misalignments, the total expected quasi-static TE can thus be established. Using an iterative approach, the analysis also accounts for unequal load sharing amongst the planets due to differences in the instantaneous mesh stiffness between out-of-phase planets. An arbitrary example illustrating the effects of phasing is presented in Figures 1 through 3, for factorizing and non-factorizing designs, with ‘n’ planets, and sun, planet and ring tooth numbers of z_s , z_p and z_r respectively. For simplicity, each planet experiences equal load with a constant mesh stiffness, the details of which are presented in Table 1. Here, without presenting the specific details of load or geometry, the magnitude of the TE is irrelevant, and the example is merely presented to provide the reader with a greater understanding of planetary phasing, and the potential reduction in TE with only slight modifications to tooth numbers.

Example 1 is factorizing, such that the phasing of all S/P are identical.

Table 1 Tooth numbers for factorizing and non-factorizing designs

Example	Teeth			n	Equal planet spacing = integer	Factorising = integer
	z_s	z_p	z_r			
1	27	31	90	3	$(27+90)/3 = \text{YES}$	$27/3 = \text{YES}$
2	30	34	99	3	$(30+99)/3 = \text{YES}$	$30/3 = \text{YES}$
3	29	31	91	3	$(29+91)/3 = \text{YES}$	$29/3 = \text{NO}$

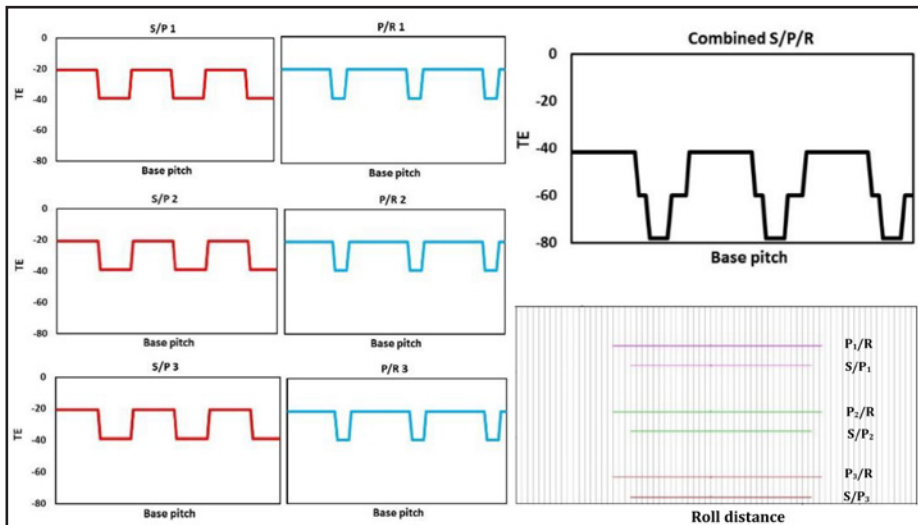


Figure 1 Example 1 – factorizing.

Likewise, the phasing of all P/R are identical, as illustrated in Figure 1. Note however, regardless of the factorization, the length of the path of contact of the S/P is less than that of the P/R, as illustrated in the phasing diagram Figure 1, whereby the P/R engage and exit mesh before and after the S/P respectively. In this example, the total combined TE is a direct combination of the S/P and P/R. Example 2 is still factorizing, however there is a distinct shift in the phasing of the S/P with that of the P/R as illustrated in Figure 2. As a consequence, when the TE of the S/P is combined with that of the P/R, the total TE ($17\ \mu\text{m}$) is significantly less than that presented in example 1 ($37\ \mu\text{m}$). Finally, example 3 adopts a non-factorizing design such that the phasing of all the S/P are different, as are the P/R. As a consequence, the total TE has been reduced to only $6\ \mu\text{m}$, as illustrated in Figure 3.

Macro Geometry Design

The objective of this research was to utilize the theory of phasing to optimize an existing epicyclic gearbox to produce the lowest TE, whilst understanding the resulting implications with regards to the complexity, cost, weight and possible risks. To facilitate this, an initial design and detailed specification was required, whereby a load spectrum, together with a required ratio and epicyclic arrange-

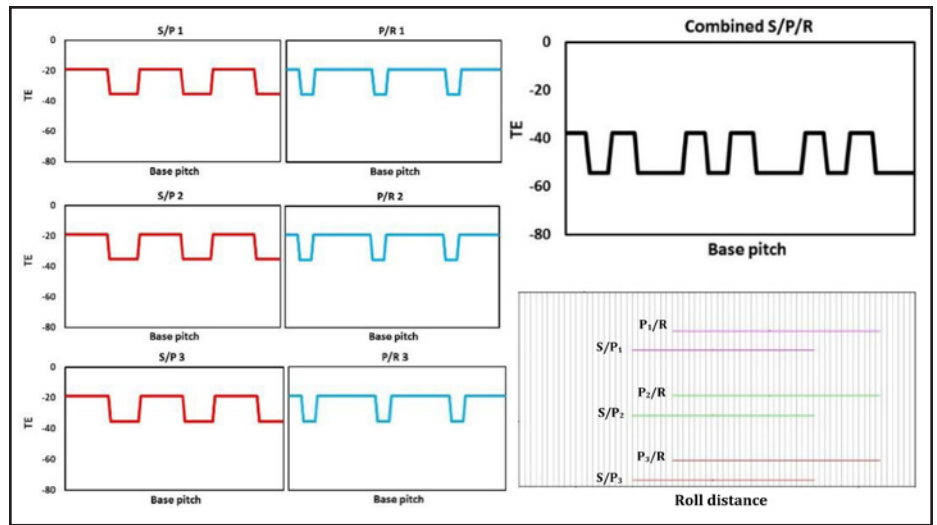


Figure 2 Example 2 – factorizing.

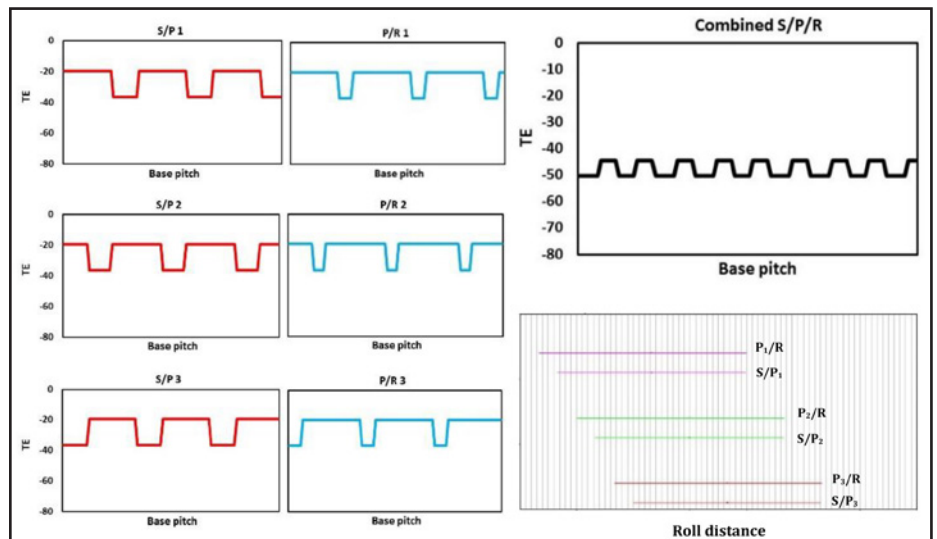


Figure 3 Example 3 - non-factorizing.

ment fully defined the system, as detailed in Table 2. Each design was analyzed in the first instance for strength, in accordance with ISO 6336:2006, then optimized by analyzing the elastic mesh deflections such that the transmission

error was further minimized using micro geometry corrections. In addition to the optimization process, each gearbox was fully designed and detailed, including housings, carriers, shafts, bearings, splines and the lubrication delivery system, only after which can the true benefits and implications of each design be fully understood.

Gearbox A. The base design was an existing spur gear system with 5 planets, and sun, planet and ring tooth numbers of $z_s = 35$, $z_p = 32$ and $z_r = 100$ respectively, such that the planets were equally spaced and factorizing.

Gearbox B. With only slight modifications to the tooth numbers specified in Gearbox A, and a small change in the gear ratio, the macro geometry was modified such that it was now non-factorizing by adopting sun, planet and

Table 2 Duty cycle			
Duty cycle	Ring speed (rpm)	Ring torque (Nm)	Time (hours)
1	200	5100	40
2	368	10535	40
3	510	7020	40
4	760	5102	40
5	1146	3390	100
6	1375	3270	100
7	1528	3300	100
8	2188	2305	100
9	2840	1583	80
10	3500	1500	60
11	-390	-9215	60
12	-575	-6740	40

Note: $K = z_r/z_s + 1 = 1.35$ (solar design- fixed sun, ring input, carrier output)

Table 3 Elimination of torsional and transverse modes

Design point	Zs	Zr	Zp	Ratio	$\frac{hz_s}{n} \neq Integer$				$\frac{hz_s \pm 1}{n} \neq Integer$			
					Planets (n)				Planets (n)			
					3	4	5	6	3	4	5	6
1	14	40	13	1.35		Y	Y			Y	N	
2	28	80	26				Y				Y	
3	42	120	39			Y	Y			Y	Y	
4	56	160	52				Y				N	
5	70	200	65			Y				Y		

Table 4 Gearbox A, B and C geometry specification

		GEARBOX A	GEARBOX B	GEARBOX C
		Original	HCR	IOR
Sun tooth number	Z _s	35	36	56
Planet tooth number	Z _p	32	34	52
Ring tooth number	Z _r	100	104	160
Normal module	M _n	4	4	2.6
Normal pressure angle	a _n	25	17.5	20
Helix angle	β	0	0	7.364
Facewidth	b	21	27	65
Transverse contact ratio (S/P)	ε _a	1.430	2.195	1.656
Transverse contact ratio (P/R)	ε _a	1.530	2.158	1.790
Overlap ratio	ε _β	0	0	1.02
Number of planets	n	5	5	3
Factorising		YES	NO	NO

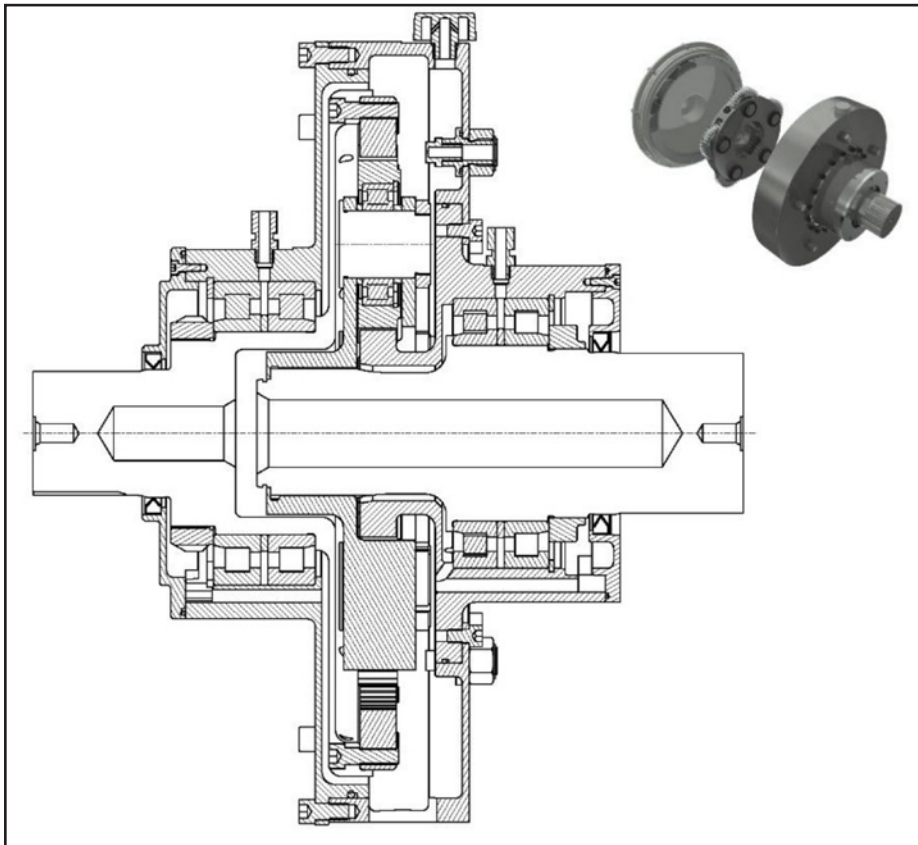


Figure 4 Gearbox B, HCR spur design.

ring tooth numbers of z_s=36 z_p=34 and z_r=104 respectively, while maintaining equal planet spacing and the use of 5 planets. The basic rack profile and pressure angles were modified such that a transverse contact ratio greater than 2 was achieved, resulting in an HCR design.

Gearbox C. Gearbox C adopted helical gears, with an integer overlap ratio slightly larger than 1. Table 3 presents a list of viable tooth numbers, without addendum modification, which satisfied the required gear ratio, equal planet spacing, and the potential to eliminate torsional and transverse modes of excitation, based on equations 1 and 2 respectively, analogous to that previously presented by Palmer and Fuehrer (Ref. 2), for the first harmonic (h). Equal planet spacing is represented by the shaded cells in Table 3.

$$\frac{hz_s}{n} \neq Integer \tag{1}$$

$$\frac{hz_s \pm 1}{n} \neq Integer \tag{2}$$

Taking into consideration cost, weight, planet load sharing factors, shaft sizing and bearing loads, design point 4, with 3 planets, was considered a good compromise based on gear diameter and module and gave a balanced design with regards to contact and bending safety factors. Furthermore, it provided a sequential design with equal planet spacing, albeit at the expense of potential transverse vibrations. The final macro gear geometry chosen for all three gearboxes, A, B and C, is presented in Table 4. Detailed gear stress analysis for both new designs (B and C) was conducted in accordance with ISO 6336:2006, using the load spectrum presented in Table 2, ensuring each proposed design provided minimum contact and bending fatigue safety factors of 1.0 and 1.4 respectively. Each design adopts a suitable planet load sharing factor determined in accordance with AGMA 6123-B06, depending on planet numbers and system flexibility. The remaining mechanical design of both Gearbox B and C was conducted in accordance with 1) AGMA 6001-E08 for shaft stressing, 2) ISO 281 2007 for advanced bearing life, 3) DIN 5480:2006 for spline geometry,

and 4) SAE M-117 for spline stress analysis, the results of which are illustrated in Figure 4 and 5.

Micro Geometry Design

The macro geometry established for the HCR gearbox (B) and IOR gearbox (C) largely defined the likely magnitude of expected TE of the system. However, loaded deflections and random manufacturing errors will exacerbate the true operational TE, and must be further minimized with suitable micro-geometry corrections. This requires a detailed understanding of the likely gear misalignments expected during operation. Including the loaded and no-load (manufacturing) errors in both the transverse plane (profile) and across the facewidth (helix slope) of the gear. It is obvious therefore, that gears can only be truly optimized at a single load, and any deviations from which will change TE, stress and power loss. To optimize the gears in gearbox B and C, an input torque of 3000Nm was chosen, at 1500rpm, as this torque level was common throughout the load spectrum.

Loaded helix slope deviation (f_{sh}).

The loaded shaft deflections, including both bending and torsion, were established for the sun, planet carrier and ring, using ANSYS finite element analysis (FEA) whereby the actual component architecture was analyzed under operational loads and boundary conditions. The ring and sun gear were analyzed by incorporating the base tangent and axial forces where applicable, located at the point of planetary contact, thus establishing the resulting deflection in the direction of the line of action, across the face width of the gear. The planet carrier pins were subjected to twice the tangential force ($2F_t$) and an overturning moment (F_a/d_p) to compensate for the axial gear forces, where applicable. An example analysis of gearbox C is illustrated in Figures 6 through 8.

Loaded Profile Slope deviation (δ).

In the transverse plane, each tooth deflects by an amount (δ) which is proportional to the mean mesh stiffness (C_v), facewidth (b) and transverse load (F_t). This deflection value is used as a first approximation for the amount of tip relief required in the optimization process.

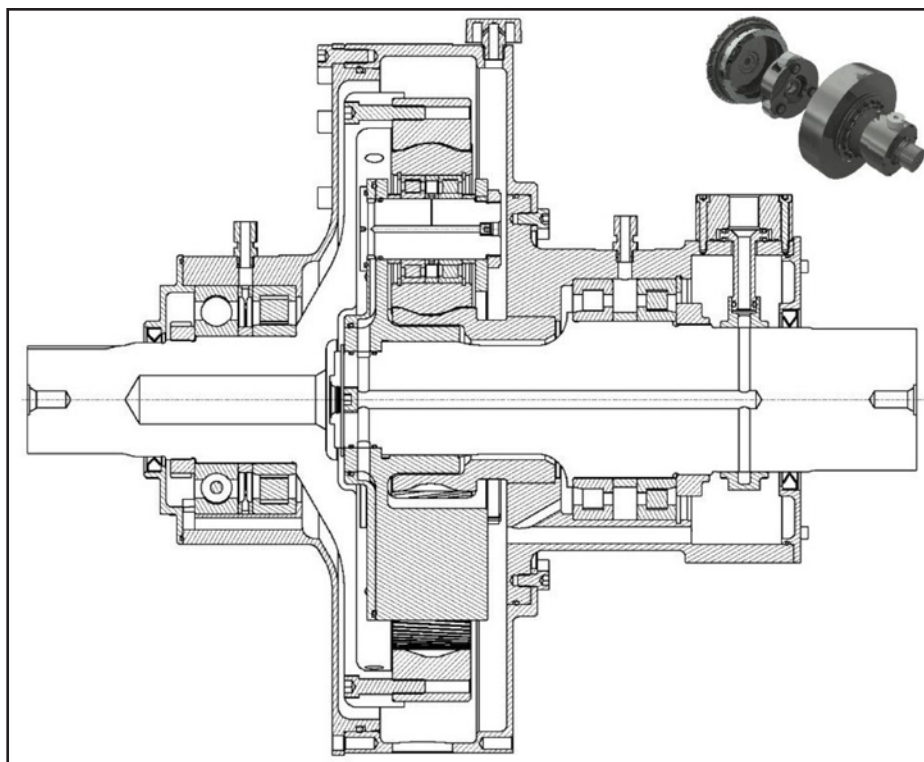


Figure 5 Gearbox C, IOR helical design.

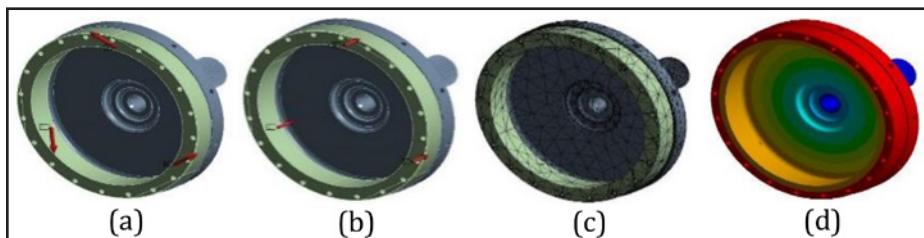


Figure 6 Ring FEA with (a) base tangent forces (b) axial forces, (c) mesh discretization and (d) deflections.

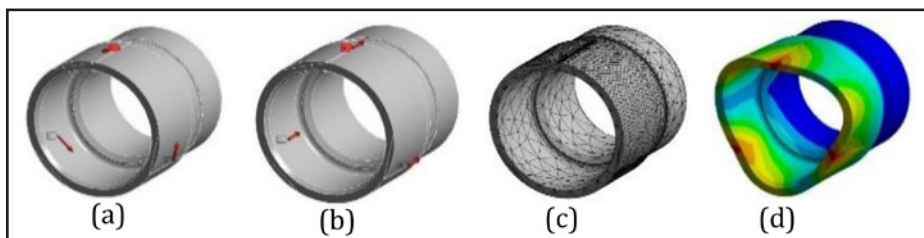


Figure 7 Sun FEA with (a) base tangent forces (b) axial forces, (c) mesh discretisation and (d) deflections.

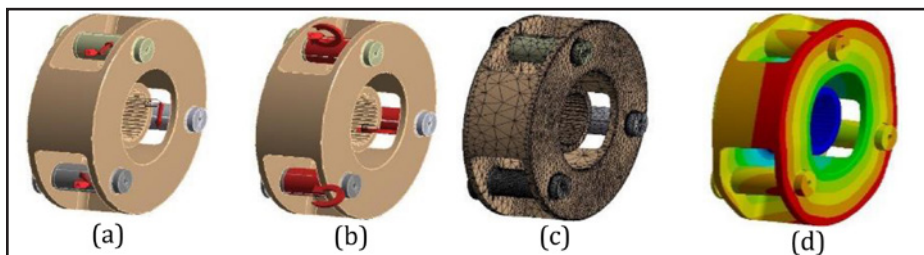


Figure 8 Planet carrier FEA with (a) tangential forces (b) overturning moment, (c) mesh discretization and (d) deflections.

$$\delta = \frac{F_t}{b \cdot C_v} \quad (3)$$

Manufacturing helix slope deviation (f_{ma}).

In addition to loaded deflections, it is necessary to establish the likely random manufacturing helix slope error ($f_{H\beta}$) of the gears (based on the gear quality grade), the shafts and housing (f_{ca}) to establish an overall maximum expected manufacturing helix misalignment (f_{ma}).

$$f_{ma} = \sqrt{f_{H\beta 1}^2 + f_{H\beta 2}^2 + f_{ca 1}^2 + \dots + f_{ca i}^2} \quad (4)$$

Consequently, the loaded shaft deflections (f_{sh}) and manufacturing errors (f_{ma}) can be summed and halved to provide the amount of crowning (C_β) required for the optimization analysis.

$$C_\beta = \frac{F_{ma} + F_{sh}}{2} \quad (5)$$

Manufacturing profile slope deviation (f_a).

The manufacturing profile slope accuracy (f_a) which is obtained directly from the gear quality grade provides an indication of the design sensitivity to manufacturing quality. That is, if the magnitude of the profile tolerance is large compared the mean mesh deflection and tip relief, it may have a significant impact on the transmission error.

Results

Once the loaded and random manufacturing errors were established, the system was accurately optimized. Tip relief was chosen to be linear starting at the highest point of double (HCR) and single (IOR) tooth contact which often provides the lowest noise designs, but at the expense of higher contact stresses. A five-step approach was undertaken to further optimize the gears, as follows.

1. Evaluate the gear performance with no misalignments or micro-geometry corrections. This will provide baseline results.
2. Starting with the minimum estimated tip relief established in accordance with equation 3, systematically increase the tip relief until non-conjugate contact is eliminated, without the start of contact occurring unnecessarily far away from the tip.
3. Using the minimum required amount of tip relief established in step 1, introduce helix slope errors equal to $f_{ma} + f_{sh}$. This provides baseline results for the gears without crowning.
4. Introduce an amount of crowning established in accordance with equation 5, together with tip relief.
5. Check the sensitivity of the design under possible profile slope errors of f_a .

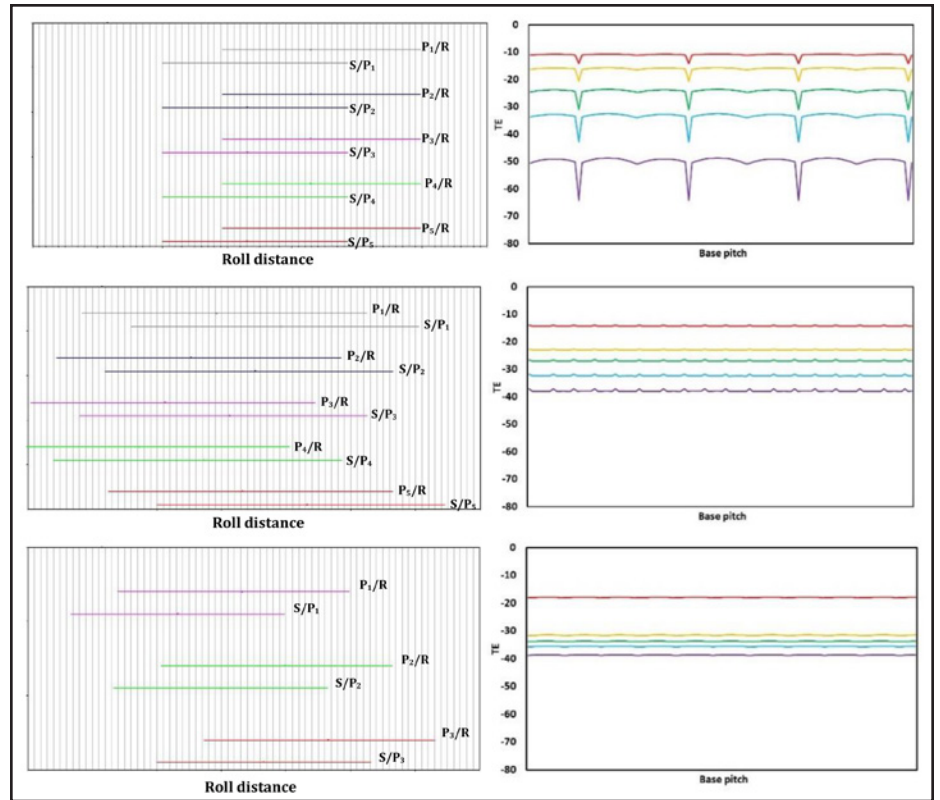


Figure 9 Phasing and transmission error for gearbox A (top), B (middle) and C (bottom).

With the optimized macro and micro geometry, the TE was established for all three gearboxes, the results for which are presented in Figure 9, at various torques up to 10kNm at 2kNm intervals.

Discussion and Conclusions

Gearbox A was a simple factorizing spur design, with 5 planets. This base design, without any micro geometry modifications, exhibited significant TE as illustrated in Figure 9. With only slight amendments to the tooth numbers, pressure angles and tooth height, a non-factorizing HCR gearbox was designed which significantly reduced the TE. With the introduction of the IOR Gearbox, also non-factorizing, this was reduced even further to sub-micron levels across the entire load spectrum.

Hence, the use of phasing, combined with increasing the transverse or axial contact ratio has been shown to dramatically reduce TE. However, every design concept had significant ramifications, as follows.

1. Choosing a factorizing design such that the torsional mode of excitation is neutralized at meshing frequency, does not eliminate torsional excitation at certain higher harmonics or other transverse and rotational excitations.
2. The HCR design is vastly simplified, mainly due to the lack of axial gear forces. Conversely, the IOR design required a much larger gear face width to a) accommodate suitable planet bearings, and b) reduce the magnitude of the helix angle required to maintain an IOR, and therefore reduce the axial forces, and planetary moments.
3. The HCR gearbox adopted a simple side spray lubrication system via jets situated at various static positions around the housing. This minimizes churning losses, improves efficiency, and was deemed suitable to lubricate the gears and single planet bearings. However, concern lay with the IOR gearbox, and the need to ensure adequate lubrication to both planet roller bearings — specifically that closest to the carrier — which may not receive satisfactory splash lubrication. Thus the IOR gearbox

adopted a more complex delivery system, via the carrier shaft, simultaneously providing oil to the planet bearings, via the pin, and the planet gears, via the carrier walls. Here, the oil jets are static in relation to the planet positions, such that they can supply a constant jet of oil directly into and out of mesh, with a jet velocity equal to or greater than the pitch line velocity. However, this required a non-contact rotating union delivery system, accurately constrained via a complex two-bar linkage system. See Figure 5 for further details.

4. Sequentially phased designs produce a small residual radial load. However, that said, even an in-phase design, with balanced radial loads and therefore a theoretical requirement for no radial support, may still exhibit a potentially much greater residual radial load due to unequal planet load sharing. As a consequence of this load, and any potential external radial loads generated due to the eccentricity of any connecting shafts into and out of the gearbox, both the input (ring) and output (carrier shafts), in these examples, were fully supported.
5. IOR axial forces must be reacted by, and accounted for, in the life of suitable ring shaft bearing. Note that since the sun gear was static, the axial loads were easily reacted, whilst those on the planet carrier cancelled.
6. The added complexity of adopting helical gears, with the need for twice as many planet bearings, large facewidth gears and a complex lubrication system, produced a design which was considerably heavier than the HCR design. It may therefore be assumed that HCR design is a sensible compromise, however, it should also be noted that the sensitivity of the HCR TE due to pitch and profile deviations were such that a greater gear accuracy would be required to maintain the benefits of such a system.
7. The benefits of phasing is more complex than simply ensuring a design factorizes or not. The phasing diagrams presented throughout, highlight the need to consider the relative positions and length of engagement of the sun/planets, planet/ring and ring to sun.
8. Finally, the entire design process is incredibly iterative, and very difficult to publish in a logical fashion. However, it is only once the entire process is complete, together with the corresponding detailed designs, can one fully understand the true implications of any concept design choices. **PTE**

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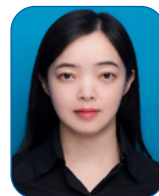
Brian Shaw is Professor of Transmission Materials Engineering, the Director of Design Unit and Director of Business and Engagement in the School of Engineering. Since 1993 Brian has worked within the field of gear metallurgy, carrying out research into micro-structural aspects of the fatigue strength of gear materials, and in particular the crack initiation and propagation in pitting and bending fatigue. His research includes the investigation of the influence of heat and surface treatments on the bending and contact fatigue strength of carburised, nitrided and induction hardened gears, the effect of residual stress, surface texture and lubricant additives on pitting in gears. He is an acknowledged expert on residual stress measurement by X-ray diffraction and micro-magnetic techniques and is a consultant to industry on gear failure.



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Design Reviews — What to Review and When

Donald Labriola P.E.

Design reviews vary greatly by industry and regulatory requirements. We typically define them as *Guidelines* rather than *Procedures*, as this allows flexibility in their execution—both to skip over non-relevant sections and to dig deeper for those areas that go beyond the typical design and require closer examination. Having them as a “*Procedure*” can interfere with both of these variations. Our designs are mostly electro-mechanical- and motion control-oriented, so some of our checkoff list may not be needed in your application, while other whole areas may be required for your design reviews!

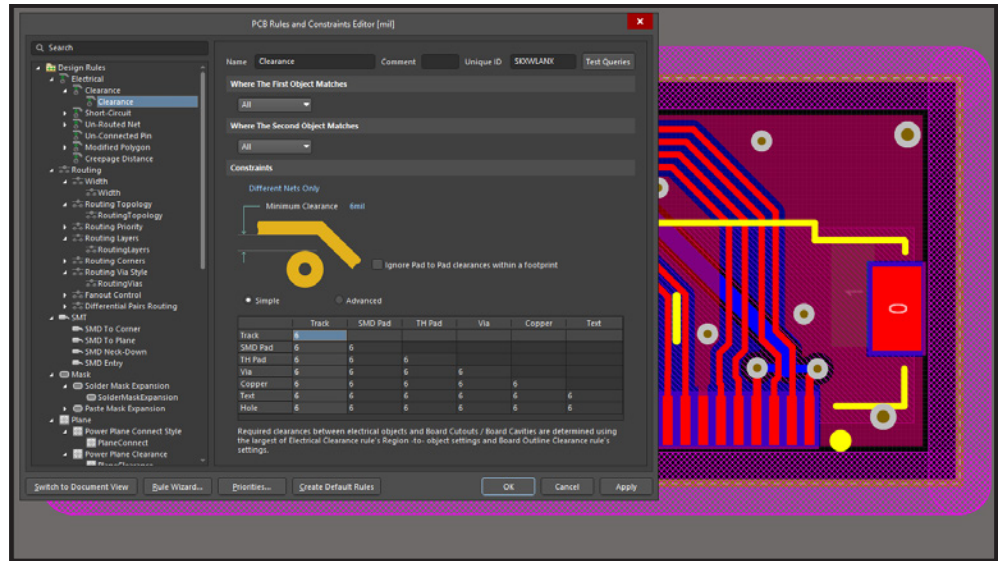
Here are what we cover in our typical design reviews. Some are trivial—did the title block get updated on all the sheets after a revision? Some are housekeeping—make sure the parts lists and fab drawings are updated from the final pass. Others pass on tribal wisdom, like asymmetric mounting of boards (see 4.5 below). Try to gain as much advantage when you do design reviews; they can result in greatly improved designs and can cut multiple iterations out of the process!

Regulatory

- 1.1 What requirements are specified for the system or subsystem?
 - 1.1.1 Are we following? Plans for agency approval?
- 1.2 Is this a modification of an existing system that needs specific items to remain under existing compliances, and can those items remain unchanged?
 - 1.2.1 Submit any changes to certification agency for approval or testing.
- 1.3 Are there specific procedures in place to avoid affecting critical sections of the design and critical components? Verify we are following them.
- 1.4 Do internal and external agencies need to review the changes for continued compliance?
- 1.5 Have all RoHS, Reach, etc. requirements been met with the components that have been selected? Have these been documented so they can be tracked. Back-ending this function is very difficult and may force a design turn!

Housekeeping

- 2.1 Verify title blocks, signatures, fabrication drawings
- 2.2 Verify Design rules consistent with manufacturing, and with regulatory (i.e. trace spacings)



Design rules make it easy to make sure requirements are being met while the design is progressing.

- 2.3 Verify Parts list generated from current board revision and variation — check time/date stamps
- 2.4 Only PDF version of drawings should be signed, not the source, as the signature needs application each time the drawing is changed; putting this in the word file or mechanical source ends up with the output being signed without the signatory having to be present to check!

Interfaces

- 3.1 Verify Connector type and pinouts, orientation
- 3.2 Verify I/O logic level compatibility, pullups, protection, especially for signals that interface externally.
- 3.3 Verify protection of devices connecting across power domains for power timing issues; make sure driving an input will not back power sections not yet powered up as latch up may happen.
- 3.4 Examine all signals crossing clock/time domains — are they re-clocked properly; are there asynchronous timing issues (metastability)?
- 3.5 Verify footprints for all parts — sufficient for soldering, correct board density
 - 3.5.1 For parts available with multiple footprints, are we using the most commonly available variety? Are alternate sources actually available in that footprint?

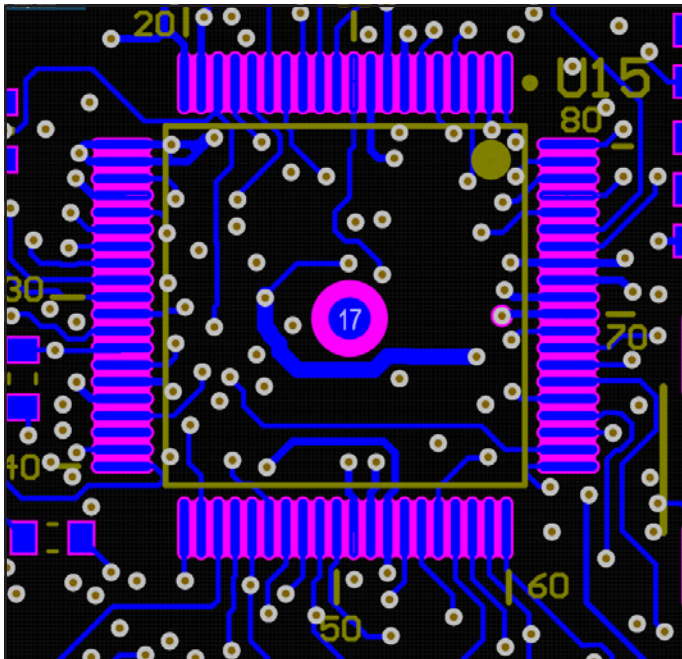
<input type="checkbox"/>		74AUP2G38DC,125 IC GATE NAND OD 2CH 2-INP 8VSSOP	\$0.56000	766 - Immediate
<input type="checkbox"/>		74AUP2G38GD,125 IC GATE NAND OD 2CH 2-INP 8XSON	\$0.14000	62,727 - Immediate
<input type="checkbox"/>		74LVC2G38GD,125 IC GATE NAND OD 2CH 2-INP 8XSON	\$0.14000	38,084 - Immediate
<input type="checkbox"/>		74AUP2G38GT,115 IC GATE NAND OD 2CH 2-INP 8XSON	\$0.86000	75 - Immediate

Figure 3.5 shows differences in availability even from same manufacturer for the same basic part number. The middle two choices seem to have a lot more flow. You should check multiple distributors. Talking with a company rep may also gain insight.

This particular package was popular with multiple vendors (not shown).

3.5.2 Especially for connectors — is there clearance for any tie down points, including brackets which to avoid shorting the surface traces below the connector. Is there sufficient hold down mechanical strength? Is there clearance for screw heads or nuts holding these parts down (if applicable).

3.6 Do all footprints have a clear Pin 1 marker

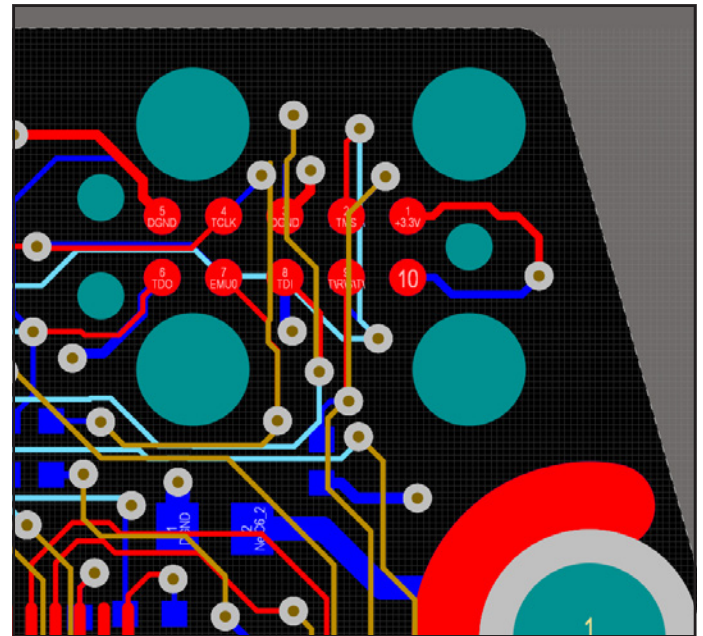


Dot to upper right is pin 1.

This also shows a fiducial (middle marked with 17), and numbering of pins around the IC to help with troubleshooting and debugging.

- 3.7 Do Diodes and LED and polarized capacitor have orientation clearly marked?
- 3.8 Sufficient ESD protection for exposed signals (those not internal to board)?
- 3.9 Is there a ground trace around exterior of board (if possible) to reduce induced ESD when picking up the board by the outside edges? This can significantly reduce stress on the board if a customer does not follow proper ESD ground strap procedures.

- 3.10 Check for sufficient power ratings all resistors — 60% power rating, peak higher ok if duty-cycle limits heating.
 - 3.10.1 LED series resistors and opto-coupler series resistors are common offenders.
- 3.11 Verify Capacitor voltage, material type, current rating. High-frequency circuits need appropriate dielectric!
- 3.12 SPI bus — verify MOSI and MISO properly connected with respect to the **controller!**
- 3.13 Verify any transient states that may occur while processor is coming up; make sure pullup and pull down resistors will handle the transition properly until the processor can configure the IO to controlled levels.
- 3.14 Verify isolator outputs when only one side of the other is powered to make sure that power up transient power issues are avoided.
- 3.15 Make sure all capacitive A/D converters are fed from a passive low pass filter to prevent accuracy and carry over issues.
- 3.16 Are Programming pads available w/o disassembly (if possible)?



Pads for emulator tap are laid out on both top and bottom of board to make the connection accessible from either side of the processor board.

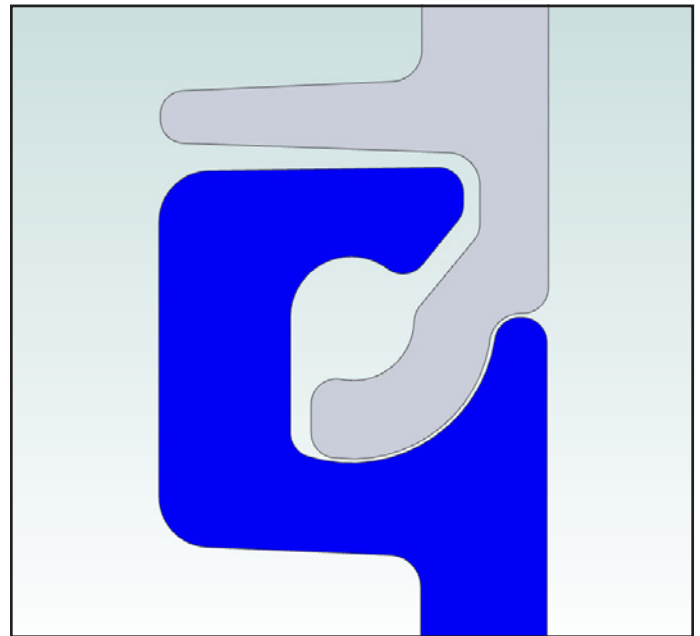
- 3.17 Make sure to provide good ground pads for o-scope/ logic analyzer for debugging.
- 3.18 Bring out pads where possible of critical signals to vias with sufficient holes to hold scope probe. This may not be possible for very high-speed signals due to excess capacitance, but testing means should be determined early.
- 3.19 Verify current rating of high current traces — wider traces needed on inner layers due to less cooling!
- 3.20 Verify minimum and maximum holes and minimum annulus. For low-density boards .010 holes are less expensive than .008 if .008 not needed. Avoid smaller vias unless actually needed and you have processes in place to provide them at an acceptable cost.

- 3.21 Prefer 1 oz (or less) on inner layers unless heavier copper is needed for current.
- 3.22 Move high current traces to outer layers, if possible. (Sometimes using adjacent layers for counter flowing currents is needed to minimize EMI by reducing the loop area).
- 3.23 Avoid discontinuities under very high-speed in ground planes under fast traces as these cause signal ringing and unwanted coupling. Stitch together to minimize altered paths if unavoidable. Avoid very high-speed signals as ringing can easily narrow the “eye” to where the board will not be reliable.
- 3.24 Use thermals for through-hole connections to heavy traces or power planes.

Mechanical

- 4.1 Check connectors (and other parts with metal) for areas that may short surface traces.
- 4.2 Verify the mechanical dimensions including pads, plated through-hole requirements, and mounting holes; verify board with 3D!
- 4.3 Verify needed screw lengths—use standard commonly available screw sizes and lengths. Do tolerance analysis to verify sufficient threads w/o exceeding allowed envelope over tolerances.
- 4.4 Verify pads under screw heads for sufficient head/nut size, including hole diameter clearance which allows a screw to be off-center through-hole.
- 4.5 Try to make mounting holes on PCB asymmetrical. This helps avoid strong vibration modes of the board. Nice symmetrical mounting holes make for strong vibrations when the wrong vibration frequency is found. An added screw off center can significantly spoil the “Q” of the vibration modes of the board. Think of a thumb on off center on a snare drum!
- 4.6 Keep tall or sensitive components away from board edges and mounting holes. Locate and orient the long direction of SMT components (especially larger ones) so as to minimize mechanical stress when connectors

- are inserted, when the board is mounted, and when the board is depanelized.
- 4.7 Verify pin 1 markings all components, K on diodes. Through-hole LEDs have square pad for anode (longer lead).
- 4.8 Put a lead marker every 10 pins for large packages for easier debugging (when possible).
- 4.9 Place fiducials for SMT well separated, with extra fiducial near high-density parts. Make sure fiducials will not be found if board is flipped or rotated so a misplaced board will fail looking for these before parts get placed wrong!
- 4.10 Verify connectors in arrays will not overlap with other parts in the array nor with break apart lines.



This is two extrusion halves. The signal from the inside of the box (Right) does not have a direct path to exit the box. The long and thin clearance blocks all frequencies likely to be encountered, having a cutoff frequency much above the requirements (blocking all lower frequencies with a very high attenuation). A screw goes into the center hole to hold the two pieces together and to push the edges in contact. The clearance without the screw in place makes assembly easy.



Symmetric



Asymmetric

A quick search of “vibrational modes of a rectangular membrane” will provide animations of the vibration modes. These require symmetry to allow the energy to easily propagate from one region to another. Break the symmetry, and the modes become much fewer and less effective.

Mechanical enclosure design

- 5.1 Look over design for electrical noise consideration when choosing a RoHS electrical conversion coating versus anodization.
- 5.2 Try to design overlaps to form “waveguide in cutoff” for joints to keep electrical noise from making it through a gap — either in or out of electronics.
- 5.3 Make sure safety grounds are dedicated and masked (preferably electro-conversion plating); do not share the safety ground points with other mechanical functions unless you have regulatory signoff, as this is frequently not allowed.

General

- 6.1 Design either with multiple source parts or with alternate parts, where possible.
- 6.2 Look up configurations—what parts are stocked in quantity. Avoid those who few others are ordering. Look for parts available with multiple footprints, which are most in use and have multiple large-quantity alternate sources. Just because it is on the data sheet does not say they will be available!
- 6.3 Mix capacitor sizes to avoid simultaneous resonances; a decade apart in bypass values helps suppress. Design to keep the loop area from ground plane to cap, and back to a minimum to minimize the inductance. This will extend the frequency coverage of the cap.
- 6.4 Leave some spare footprints when possible — especially on new designs. Makes “blue” wiring much easier!

Standard mechanical materials & machined parts

- 7.1 Standard screw lengths, Phillips (or Allen head where needed), stainless for RoHS; MEPS reduce assembly time.
- 7.2 Tolerance to guaranteed screw depth into threaded holes.
- 7.3 Look at dimensions of standard raw materials; to get precise dimension use a light skin cut (for visible parts to have a nice look) on machined parts.
- 7.4 Look at how the part is to be held in the vice on a mill and dimension from the fixed vice face and, typically, the left side of the part as it is held. Keep these same references when the part is rotated in other views on drawings.
- 7.5 Try to take advantage of standard tool sizes for non-critical holes like vents. Plunge cuts are much less expensive than milled-shaped. Larger-diameter tools make for faster cutting; give a reasonable radius at corners so small tools are not needed (where possible).
- 7.6 Have your machinist review the drawings early; many features can be easily altered for better manufacturability.
- 7.7 For bent metal parts, the tolerance typically grows .010 for each bend (standard processing).

- 7.8 Always work from the latest standard punch tool list for sheet metal parts; multiple hits are much less expensive than custom tools unless the quantity is very high.
- 7.9 Dimension tolerances for what is actually needed: much of the cost is not in machining to .001, but in verifying the part to .001; if .010 is sufficient, don't over-specify (but make sure the part will work with the tolerances given!)
- 7.10 Make sure tolerances are shown between physical points that remain on the part, not off part conjunctions. Real places are much easier to measure when checking the part; projected points take special fixtures.

Use both informal and formal design reviews. Early informal design reviews can set the tone early and save much work by helping with the philosophy and practicality. Formal reviews are needed to document and are another stage to eliminate issues before they surface in the field. If you find issues that slip through or were caught by careful attention in a design review, add them to the checklist you are using, i.e. —keep improving!

Know what the requirements are — even if you are specifying them yourself. Document these early; it is much faster to document as you are making these decisions than trying to reverse-engineer what you did! Make sure these created requirements are reviewed with the customer early in the design.

I would love to hear your suggestions for both electromechanical design and other areas of design! **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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The Influence of Rolling Bearing Profiling on Rigidity and Rating Life

Benjamin Abert

The FVA-Workbench is a manufacturer-neutral tool for the simulation and calculation of transmission systems. As product development cycles become shorter, powerful modeling approaches and calculation algorithms become increasingly important. The predominantly analytical approaches in the FVA-Workbench deliver fast and reliable solutions to all important issues related to drive technology. For bodies that cannot be accurately described analytically, the results are supplemented by suitable numerical methods. The intuitive modeling techniques in the FVA-Workbench guarantee simulation of consistent, valid, and manufacturable gears every time.

The calculations are developed, analyzed, and validated in research projects by Forschungsvereinigung Antriebstechnik e.V. (FVA, the Research Association for Drive Technology). Through member contributions and public funding, the FVA is able to organize 14,9 million euros annually in research projects at leading German universities, chairs, and research institutions. The FVA-Workbench serves as a knowledge platform, making the results of FVA research projects available

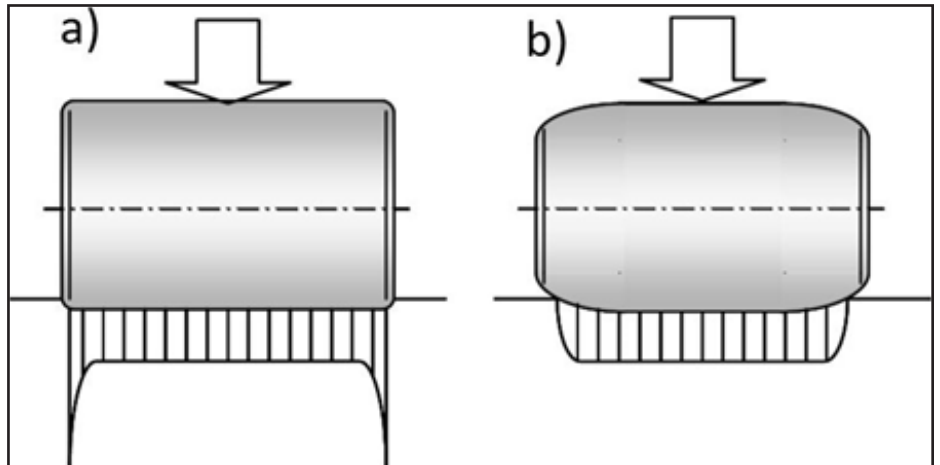


Figure 1 Pressure distribution a) without profiling and b) with profiling /1/.

and accessible to all engineers. It is no longer necessary to read through and study countless pages of scientific documentation, making the development of innovative gearboxes considerably more efficient and user friendly.

The following article will explain the detailed calculation of rolling bearings in the FVA-Workbench, based on consideration of the profiling of roller bearings.

Profiling of Roller Bearings

In roller bearings, there is line contact between the rolling elements and the raceway. If the rolling elements are perfectly cylindrical (cylindrical roller bearings) or tapered (tapered roller bearings), this leads to local pressure peaks when the end side of the rolling elements comes into contact with the raceway (Figure 1a). This can result in local pitting damage in these areas (Figure 2). To avoid these pressure peaks, roller bearings are always designed with profiling along the longitudinal axis of the roller (Figure 1b). In addition to avoidance of high edge stresses, the profiling also has an influence on the following criteria:

- Maximum roller-raceway contact pressure, especially with tilting
- Modified reference rating life according to /2/
- Tilting and lowering rigidity

Cylindrical and tapered roller bearings typically have a logarithmic profile in accordance with /2/. However, the actual depth and shape of the profiling can deviate significantly and is determined by the manufacturer, based on available knowledge for each bearing type. In order to consider the influence of different profiles on the above criteria in the bearing design phase,

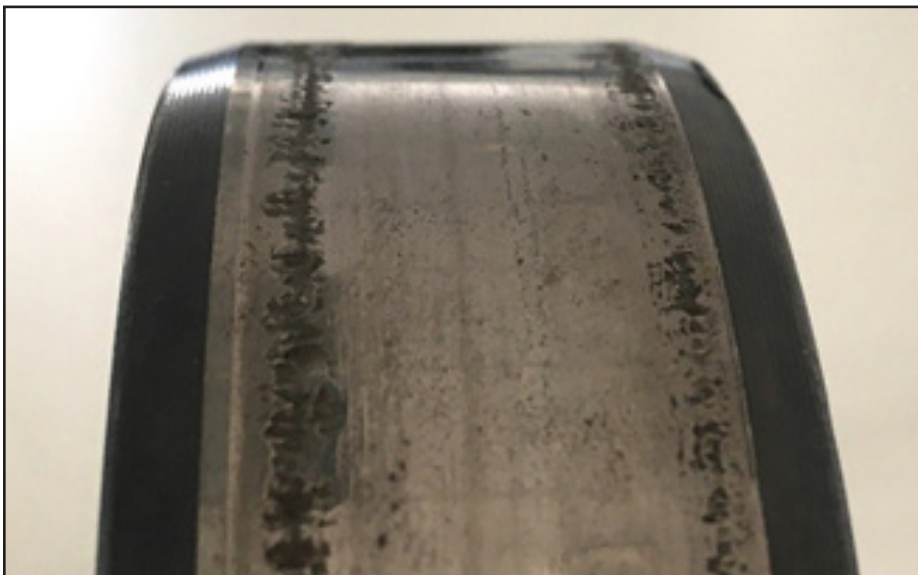


Figure 2 Local pitting as a result of profiling created by wear.

the FVA-Workbench provides the option to adapt the profile for each individual roller bearing. In addition to pre-defined profile shapes, profile curves provided by the bearing manufacturer or based on measurements can also be defined. Therefore, it is recommended to consult the bearing manufacturer in critical cases when making the final bearing selection.

Calculation Example

The influence of different profiles will be demonstrated, using the calculation of the NJ 230 type motor-side output shaft bearing from the gearbox shown in Figure 3 as an example. Three differ-

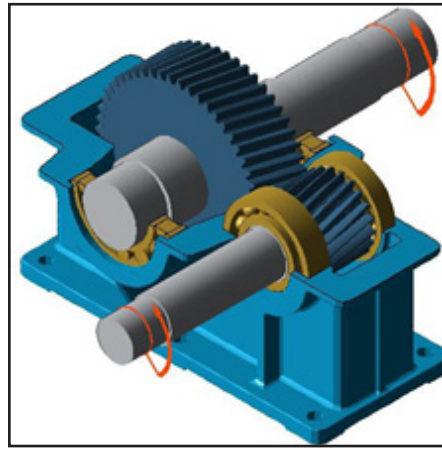


Figure 3 Example gearbox.

ent profile variations are calculated for the bearing:

- 32 μm logarithmic profile (corresponding to /2/)
- 14 μm logarithmic profile
- No profile

Diagram 1 provides an overview of the calculation results for the 3 variants. The values are all relative to the corresponding profile specified in /2/ (here:

32 μm).

Additionally, the pressure distribution along the longitudinal axis of the roller in the inner ring contact of the most heavily loaded roller element is compared for the three variants in Figure 4.

The following statements can be derived from the results:

- The profiling has no significant influence on the results of the modified rating life calculations (according to both ISO 281 and bearing manufacturer catalog calculations). Only minor differences may result from the fact that slightly different bearing forces may be calculated in the system due to the change in the bearing stiffness.
- The distribution and the maximum

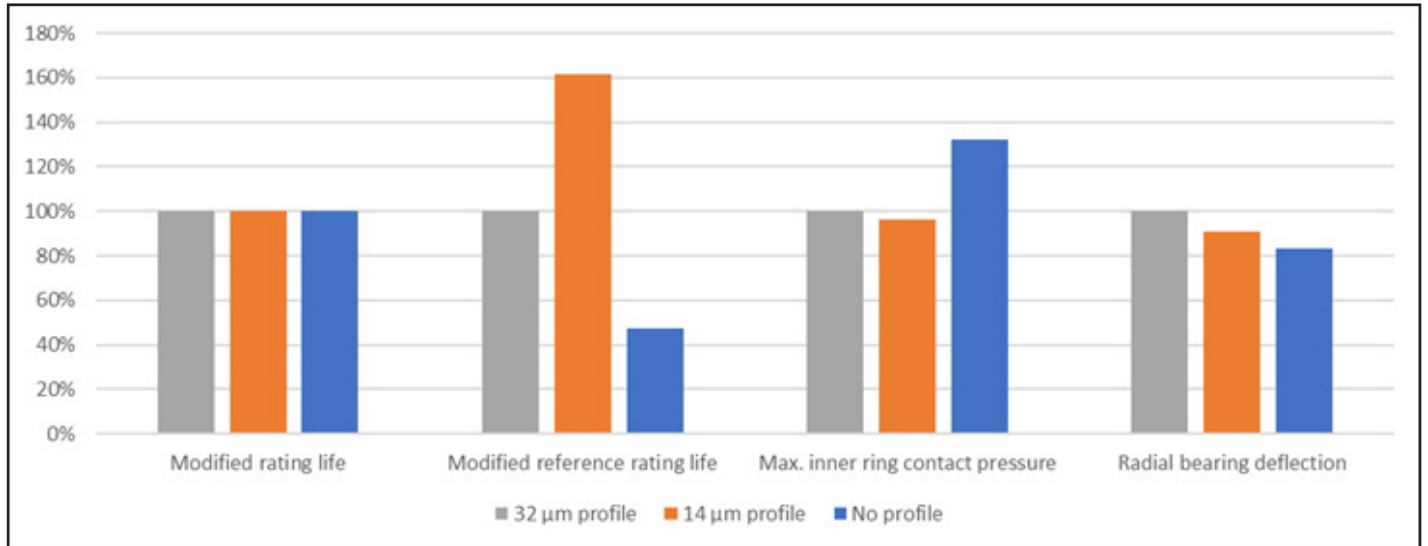


Diagram 1 Comparison of the calculation results for different amounts of profiling.

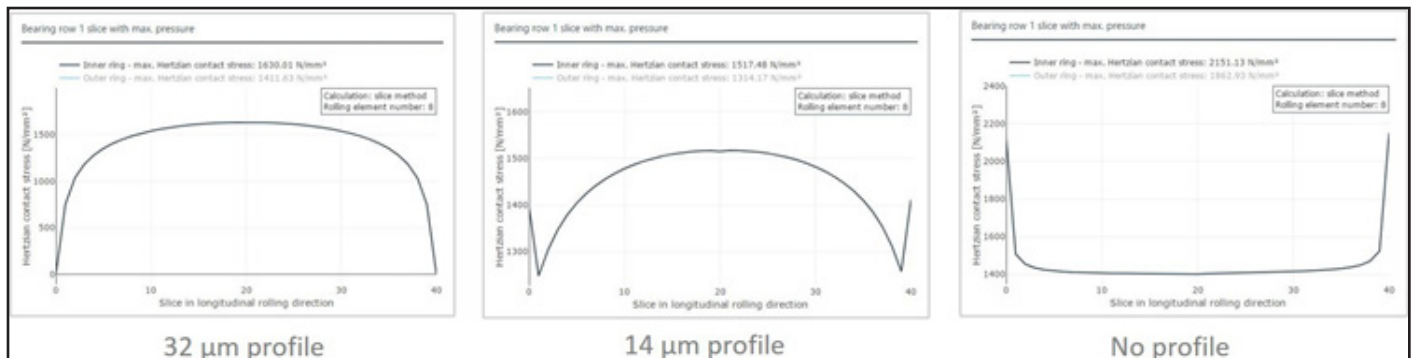


Figure 4 Comparison of the pressure distributions of the most heavily loaded rolling element.

value of the local contact pressures in the bearings are decisively influenced by the specification of different profiling. From the curves in Figure 4, it can be seen that the pressure in the middle of the roller increases with higher amounts of profiling. With lower amounts of profiling, the pressure distribution becomes more even. In this case, however, increased edge stresses may occur, especially at high tilt angles.

- Since the value of the modified reference rating life according to DIN 26281 is based on consideration of the local contact pressure, a strong influence on the rating life values can also be seen here for each specified profile.

About FVA GmbH:

FVA GmbH is a joint venture of VDMA (Verband Deutscher Maschinen- und Anlagenbau, the Mechanical Engineering Industry Association) and FVA e.V. (Research Association for Drive Technology). Founded in 2010, FVA GmbH works hand-in-hand with top-level German research institutions and leading companies from the drive technology industry toward the practical application of knowledge gained from FVA research projects. Our core competencies are the development of calculation and simulation software for drive technology, processing and conversion of legacy code structures into modern software architectures, professional service and support, and hosting technical seminars and conferences (www.fva-service.de #FVAWorkbench #FVADriveTechnology). **PTE**

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GREAT SCOTT!

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OK, you blinked and missed last month's issue of *Power Transmission Engineering*. Fortunately, you don't need a DeLorean to travel back in time — just a computer and working fingers.

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Bonfiglioli

KICKS OFF VACCINATION HUB IN JUNE

The Bonfiglioli Riduttori Vaccination HUB in Calderara di Reno kicked off June 14th.

The Calderara di Reno Hub, obtained by dedicating part of a Bonfiglioli Group plant, has a total area of 1,500 square meters. Equipped according to the protocols and functionalities provided by the vaccination plans, it began its activity immediately after cutting the ribbon and will be able to guarantee 500 vaccinations per day.

“The creation of this hub is part of a system operation on the territory promoted by Confindustria Emilia Centro, which sees the birth of an intercompany network of vaccination hubs open to all related and not related companies in the territory, their employees and collaborators and their family members. All coordinated with the institutions and the public health service. A major effort to support the community and businesses, in order to help accelerate the current vaccination campaign. We guarantee employees and their family members certain dates, which will allow them to complete the vaccination cycle by the summer break, to spend safely and with greater serenity, with a view to restarting and returning to normal,” said Sonia Bonfiglioli, chairwoman of the group and vice-president of Confindustria Emilia.

“Bonfiglioli Riduttori is proud to represent an important part of this teamwork, hosting a hub that started immediately



with the first vaccine administrations, and I'd also like to remember the other two active hubs, promoted in collaboration with Confindustria Emilia: the one hosted by IMA, belonging to our former President, Alberto Vacchi in Ozzano dell'Emilia, and the one organized by Voiláp, belonging to our president Valter Caiumi in Limidi di Soliera.

We are very proud as Bonfiglioli to be a step on this imaginary scale of solidarity that aims to drive us — also thanks to the spread of vaccinations — out of the darkness and anguish of these long months. Together, with cohesion, we can start running again,” she added.

www.bonfiglioli.com

ABB

INTRODUCES DRIVE EXCHANGE SERVICE

ABB's Drives Service team reduces the impact of unplanned downtime with the Drive Exchange Service offering. Utilizing real-time inventory and a dedicated Exchange program team, ABB can ship a replacement unit within 24 hours of a purchase order receipt.



The ABB Drives Exchange Service offering is an extension of the Expanded Drives Services offering which includes reconditioning service, preventive maintenance, and standard or premium repair, all of which are performed at ABB's state-of-the-art, ISO certified Drives Service Workshop in New, Berlin, Wisconsin. All drives are repaired by ABB certified technicians using genuine ABB parts to ensure the drive operates as designed. All work performed is factory tested and backed by at least a one-year warranty.

All ABB Drives Exchange units will have a 1-year complete drive warranty from date of shipment from ABB.

“We know that for a customer who is down, every minute is a loss of productivity and profit, possibly even raw materials,” explains Michelle Schwery, director of sales and marketing — US Drives Service. “The goal of the Exchange service offering is to get them up and running quickly.”

ABB Drives Service also offers on-site assistance and training through a nation-wide network of field service technicians. All of this is backed by 24/7 customer service and technical support.

www.abb.com

QuesTek

WINS ASM INTERNATIONAL ENGINEERING MATERIALS ACHIEVEMENT AWARD

QuesTek Innovations LLC has announced that it received the 2021 ASM International Engineering Materials Achievement Award for the design and commercialization of Ferrium C64, a novel high-performance carburizable steel enabling more durable, lighter weight transmission gears with increased power density. QuesTek will officially accept the award in 2022 at ASM's IMAT annual meeting in New Orleans.

"This puts us in the rarified company of previous award winners like the U.S. Army Research Laboratory, NASA Glenn Research Center, IBM Systems and Technology Group, GE Aviation, and Northrop Grumman Corporation, among others," said Jason Sebastian, QuesTek president. "We're grateful for the recognition by ASM."



The Ferrium C64 story began in 2005 in response to a problem that the U.S. Navy couldn't solve: how to enhance the performance and safety of its helicopters. QuesTek responded with the answer: a high-strength steel that provided gearbox longevity, increased power-to-weight ratio, and a reduction in production, operation and support costs. Ferrium C64's unique properties--high surface hardness, quench hardenability, high strength and toughness, long fatigue life, and high temperature resistance--next attracted the attention of the U.S. Army.

QuesTek, through the Army's Future Advanced Rotorcraft Drive System (FARDS) program, was awarded a subcontract from Bell Helicopter to jointly evaluate the applications of C64 in an effort to improve the performance and affordability of current aircraft drive systems. QuesTek has also demonstrated C64 in powder bed additive manufacturing, where initial results show similar properties to forged bar.

"As a leading provider of Aerospace and Defense gear material solutions, Carpenter Technology has seen significant interest and adoption of Ferrium C64," said Marshall Akins, Carpenter's Vice President of Aerospace and Defense. "Due to its excellent core and fatigue strength, as well as its high case hardness and temperature resistance, C64 is a cutting-edge solution enabling step-changes in the performance of key applications. We expect Ferrium C64 to play a major role in our specialty steel portfolio for decades to come."

"This stellar achievement sets an example for future alloy development across a range of materials and applications," added Sebastian. "The impacts of Ferrium C64 are significant from enhanced safety to increased fuel-efficiency."

This award was given to the cross-functional team at QuesTek for their direct contributions to the design, qualification and commercialization of C64 steel: Jason Sebastian, Chris Kern, Jeff Grabowski, Kerem Taskin, Tom Kozmel and Greg Olson.

www.questek.com

Koch Industries

COLLABORATES WITH MiR

Mobile Industrial Robots recently announced a worldwide strategic collaboration with one of the world's largest private companies, Koch Industries. Cooperation started between MiR and Guardian Industries, a subsidiary of Koch Industries, in 2020. To optimize productivity and internal workflows, Guardian Industries tested different solutions for automating inhouse transportation, including deploying MiR robots in two U.S. sites as pilot projects. The success of these pilot projects resulted in the agreement between Koch Industries and MiR to evaluate the technology globally.

"We have entered into this strategic agreement with MiR because it has the capacity and extensive knowledge to support us in streamlining and optimizing our logistics operations," said Antonio Blanco, global category manager, Guardian Industries. "MiR offers flexible automation solutions that can be tailored to address our current and future operational needs. We are implementing this technology at multiple facilities because we consider MiR as a long-term partner that has the experience and capabilities to support us in achieving our productivity goals."



With five autonomous mobile robots, MiR has the widest range of AMRs in the market to take over various transportation tasks, from moving smaller parts to heavy duty loads up to 2200 pounds (1000kg). The largest robots can automatically pick up, transport and deliver pallets. Regardless of the task, these collaborative AMRs are designed to work alongside human colleagues and relieve them of various physically strenuous work so they can focus on more valuable tasks.

The versatility of MiR's robots, which can be customized with different top modules to meet customer needs, is another key reason why Guardian Industries chose to collaborate with MiR, and why other Koch companies are also evaluating possible implementations.

"We will implement the robots in multiple plants with different layouts and products, so it is important for us to have a logistics solution that can fit into all types of environments and easily adapt to new tasks," said Peter Westrick, material handling engineer, Guardian. "That is exactly what MiR offers."

Autonomous mobile robots on the rise

As demonstrated by MiR's 55% increase in sales in the first quarter of 2021, Guardian Industries and Koch Industries are not the only companies that want to optimize internal transportation flows.

"We are pleased to enter into this collaboration and contribute to Guardian's productivity goals by deploying our flexible, collaborative and safe mobile robots," said Christian Clausen, sales director, MiR. "In general, we see a great potential across industries for optimizing internal logistic workflows, from inbound and outbound logistics to material handling in manufacturing plants, and our industry-graded robots can be deployed directly into these different workflows. The plant setups of today are agile and highly dynamic, and people, equipment, pallets and other obstacles can appear in what used to be open passageways."

"Our mobile robots fit these ever-changing environments very well," Clausen added. "With their collaborative, autonomous navigation, automated material transportation becomes flexible and easily adaptable without additional cost or disruption to processes."

According to robotics analyst Frank Tobe, "Almost every MiR pilot project has resulted in the client subsequently ordering multiple MiR AMRs. There are many reasons, but two stand out: First, with the addition of low-cost shelving and handling accessories, clients keep finding new applications for these versatile mobile robots, and second, MiR's navigation, fleet and handling software is simple to install and activate and provides continuing ROI. MiR focuses on flat-surface apps, which are ideal for almost all manufacturing and logistics operations around the world. I can see why Koch and other inventive multi-business conglomerates are interested in MiR. It's an ideal fit of need and product."

MiR has a global distribution network in more than 60 countries and local offices in New York, San Diego, Singapore, Frankfurt, Barcelona, Tokyo and Shanghai.

www.mobile-industrial-robots.com

PTDA

OFFERS NEW RESOURCES THROUGH PT WORK FORCE

The PTDA Foundation, through its PT WORK Force initiative, provides resources to support power transmission/motion control (PT/MC) employers in their recruitment and retention efforts as they navigate a new world of work post-pandemic. In fact, it's more important than ever to have the right people on the team to take advantage of future growth opportunities. All the resources can be accessed, free of charge, at PTWORK-Force.org.

PT WORK Force is helping employers:

- Stand out as the employer of choice with proven strategies from the PT WORK Force webinar, *Winning the Labor War: Finding and Keeping Good People in Uncertain Times*.
- Thrive in a remote work environment with tips from the PT WORK Force webinar, *Maximizing Your Remote Work Environment*.
- Determine what students are looking for in an employer. Four students from Georgia Tech University shared their work expectations. A summary of their insights from the Building Your Workforce student panel session is available.
- Evaluate if employers' compensation and benefit packages meet the needs of today's employees — especially post-pandemic. The PT/MC Compensation and Benefit Ideas for 2021 and Beyond resource reveals what employees are looking for in a contemporary benefits package.
- Promote the value of the industry and the work we do in order to attract new talent. PT WORK Force supports the Manufacturing Day as just one way for employers to get exposure for their company within the community.

Additional resources currently in development include updated job descriptions that reflect remote working needs and diverse skill set requirements and a Virtual Onboarding Resource.

Ptworkforce.org



SKF

OFFERS OIL REGENERATION SERVICE TO CUSTOMERS IN MEXICO

Industrial end-users in Mexico will now be able to make use of regenerated oil services using a unique and recently developed system from SKF.

Molecular Oil Technology (MOT) has purchased, and will operate under license, a RecondOil Double Separation Technology (DST) stand-alone unit from SKF.

SKF already uses the oil recovery system at several of its own facilities and is now in the process of making the technology available to customers around the world — both as part of its offer around the rotating shaft as well as via license partners in selected markets.

“With this solution, MOT and SKF will help customers to reduce carbon emissions and cut costs, while increasing machine performance and contributing to a circular economy,” says Nacip Fayad, industrial market business unit director at SKF in Mexico.



The DST unit removes contamination, including nano-sized particles, from lubricant oil. It is more effective than conventional filters and extends the time between oil changes in industrial operations.

The presence of nano-sized particles usually causes oil to oxidize and degrade. By removing these particles, the DST unit helps maintain oil conditions for longer. Regenerating oil can raise machine performance by preserving lubricant cleanliness. In this way, it can also cut the cost of oil purchase and disposal, and help companies meet environmental targets.

“We are very happy to have teamed up with SKF to bring the DST technology to Mexico. Our mission is to provide a sustainable solution to our customers through a truly circular use of industrial oils, which will allow our customers not only to reduce costs, but more importantly, reducing their carbon footprint,” said Michael Heidkamp, CEO, Molecular Oil Technology.

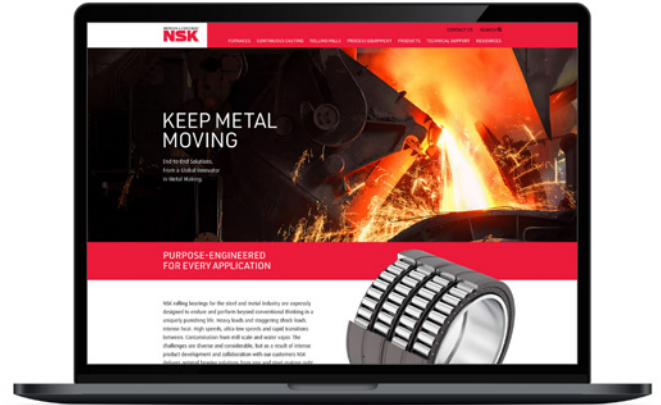
The full capacity of the DST unit purchased by MOT is approximately 2.5 million liters/year.

www.skf.com

NSK Americas

LAUNCHES WEBSITE FOR METAL-MAKING OPERATIONS

To help meet the increasing demand for high-productivity solutions in steel mills and related industries, NSK Americas has launched *NSKMetals.com*. The website presents the company’s diverse range of rolling bearing technology and service solutions expressly designed for the extreme environments found in metal-making plants.



“Modern mill operators are under enormous pressure to increase production due to global demand, while simultaneously lowering cost-per-ton,” says Paul Brda, NSK strategic segment manager. “Our intent with this website is to present game-changing products and technologies that help mills meet variable output targets, while lowering overall operating costs.”

The website highlights the specialized bearing products NSK has engineered for virtually every mill application—from furnaces and casting, to rolling mills, to the array of critical process machinery and equipment that keep everything running smoothly. It also details the comprehensive technical support the company provides on-site with NSK industry experts, in design stage with Application Engineering and in perpetuity with extensive end-to-end services.

An expanding library of technical resources provides product- and service-literature downloads. And industry-specific case studies demonstrate how NSK has made real-world improvements in mill productivity and cost control with its holistic Added Value Program (AIP).

“Our mantra is ‘Keep Metal Moving.’ We know that if one bearing fails on a segment roll in the casting facility, all downstream processes come to a halt, output ceases, and the costs quickly mount,” adds Brda. “NSK has been specializing in bearing solutions in mills for decades, introducing metallurgical and tribological advancements, and breakthrough bearing products that consistently outlast and outperform conventional solutions.”

NSKMetals.com

Schaeffler

INTRODUCES OPTIME IN THE UNITED STATES AND CANADA

Schaeffler is launching its acclaimed OPTIME condition monitoring system in the U.S. and Canada. OPTIME is an efficient, easy-to-use and low-cost solution designed specifically for the comprehensive condition monitoring of all balance of plant assets across entire manufacturing facilities.



Due to cost considerations, permanently installed vibration-based condition monitoring systems are typically used only for production machines that are directly process- or quality-critical. In fact, within the process manufacturing and automation industries, it is not uncommon for up to 95% of all assets in a production facility to be either totally unmonitored or monitored only periodically by means of route-based, manual measurements. “With OPTIME from Schaeffler, however, comprehensive and automated condition monitoring is now a cost-effective proposition for reliability personnel and facility operators,” said Frank Mignano, Schaeffler Americas manager for condition monitoring and Industry 4.0 service solutions.

Automated data analysis – powered by Schaeffler expertise

OPTIME is an easily scalable condition monitoring system that consists of wireless, battery-powered vibration sensors, a cellular gateway and an app to visualize the resulting data. This information, which is captured by the sensors, is analyzed using proprietary algorithms that draw on Schaeffler’s technical expertise, its extensive library of physical models developed and refined over many decades, and the experience in condition monitoring that Schaeffler has built up in the course of its bearing servicing operations.

OPTIME is designed to provide advance warning of potential damage to machines such as electric motors, fans and pumps. It also offers early notification of imbalance, misalignment and loose-fitting components. The OPTIME mobile app displays trends in graph format and visualizes the severity of incidents using traffic light colors, alarm states and other information. Assets can be grouped according to the user’s requirements, and their condition can be presented in a range of user group-specific views. With OPTIME, in-house maintenance personnel and external service contractors receive specific recommendations regarding the

steps required to remedy any issues, enabling them to easily plan their maintenance activities, manpower requirements and spare parts procurement in a timely and cost-effective manner.

Quick and easy setup

OPTIME can be installed and put into operation without any prior condition monitoring expertise. This means that several hundred measuring points can easily be set up in a single day. Vibration sensors are attached to the monitored assets by means of screws or adhesive, after which they are activated using the accompanying app that connects to them via near-field communication (NFC). All installed sensors communicate autonomously with each other and the gateway, thereby forming a dedicated mesh network that ranks among the most reliable and energy-efficient types of IoT networks in use in industry today.



reddot winner 2021

The sensors in OPTIME’s mesh network capture and transmit seven key performance indicators, including six different vibration readings plus temperature, via the gateway to the Schaeffler IoT Hub. The Schaeffler hub analyzes the data, and the results are displayed on the PC-based dashboard or within the included mobile app, the latter of which supports a broad range of devices commonly used by maintenance personnel and plant operators. Alternatively, the diagnostic results can be made available for integration into the customer’s own IT environment via a REST API.

The ideal complement to existing walk-around systems

OPTIME is designed to complement users’ existing condition monitoring programs by collecting 100% of the data generated by a facility’s machinery, and then automatically identifying those assets that are experiencing performance issues. OPTIME also provides more accurate diagnostics than most wireless online condition monitoring systems, thanks to its complex, proprietary algorithm-based analytics. Moreover, OPTIME’s compact size, wireless design and ease of instal-

lation enable it to be used on a multitude of assets for which permanently installed condition monitoring was previously not commercially viable. This makes OPTIME the first condition monitoring solution capable of providing a machine status overview that is truly comprehensive and encompasses all subsystems and auxiliary assets. This is important, because monitoring the condition of all assets within a manufacturing operation is fundamental to the reliable prevention of unplanned machine downtime and plant shutdowns.

2021 Red Dot Design Award winner in two categories

OPTIME was recently honored with the prestigious 2021 Red Dot Design Award in the “Smart Product” and “Industrial Design” categories for its outstanding product design, functional configuration and high level of innovation. According to Dr. Stefan Spindler, CEO Industrial of Schaeffler AG, “Our passion for technology and innovation is a key part of Schaeffler’s DNA. The fact that OPTIME received this coveted award proves that we can successfully expand our portfolio of solutions with digital services that prioritize the benefit to our customers.”

www.schaeffler.us/optime

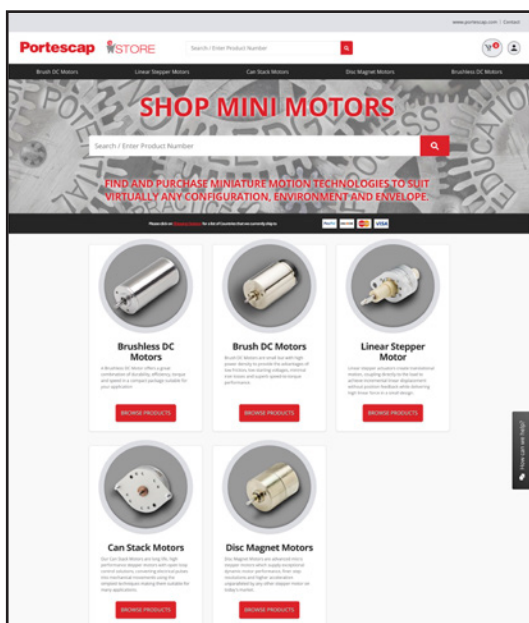
Portescap

LAUNCHES ONLINE TOOLS FOR MINIATURE MOTORS

Portescap has unveiled two new online tools to streamline the process of evaluating and buying miniature motors. MotionCompass delivers product recommendations for brush and brushless DC motors based on user criteria, and the eStore lets users quickly and easily find, configure and order Portescap miniature motors.

Here’s how they work:

MotionCompass: This dynamic tool allows users to input



operating points such as torque, speed and voltage, along with key application parameters and gearbox and position feedback requirements. MotionCompass will generate a list of motor recommendations that users can prioritize in ascending or descending order according to their speed, efficiency, power or current needs. It also immediately displays prices and availability so users can proceed to the eStore, confirm the order quantity and complete their purchase.

eStore: Portescap customers can browse or search for off-the-shelf products to suit their desired configuration, environment or envelope. When a customer selects a motor, they can easily download its specifications as well as 2D drawings and 3D CAD models, check its availability and, if the product is not available for immediate shipment, request a quote. In addition, users can customize a motor for a hard-to-satisfy application by reviewing options for gearheads and encoders. And checkouts are even faster with an e-store account.

www.portescap.com

Electromate

WINS 2021 AHTD FOUNDATION AWARD

Electromate received a Foundation Award from the Association for High Technology Distribution (AHTD), recognizing the company’s 25 years of membership and support. This is the first year the Award has been given, honoring a small group of members out of approximately 300 automation solution providers and manufacturers.

The AHTD is dedicated to maximizing the productivity, growth, and enterprise opportunities of its high-tech automation solution provider and manufacturer members. These goals align with Electromate’s commitment to driving innovation, identifying emerging technologies and products, promoting the education of automation and motion control, and fostering its relationships with industry peers.



“Electromate is proud to be honored with an AHTD Foundation Award. We strongly support their mission to increase the productivity, profitability and market share of their membership” said Warren Osak, CEO and Founder of Electromate. “Our membership in the AHTD has been instrumental in fostering partnerships and alliances to help us deliver high-tech solutions to our customers. I thank the AHTD for their steadfast commitment to advance the welfare of the high technology distribution industry.”

“Electromate has shown unwavering commitment to doing high tech better with the Association for High Technology Distribution for 25 years. We thank them for their long-standing and steadfast support of AHTD,” said Leigha Schatzman, executive director, AHTD. “We look forward to recognizing them with the AHTD Foundation Award at our Fall Meeting 2021. Congratulations, Electromate!”

www.electromate.com

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Honoring the Past, Present, and Future

Velocipede Time Machine Celebrates 'The Nation of Inventors' at Hagley Museum

Matthew Jaster, Senior Editor

Our friends at Modvic, LLC are at it again — taking their steampunk ingenuity and creating a permanent sculpture that explores the rich, vibrant history of American innovation. Guests who visit the new exhibition 'The Nation of Inventors' at the Hagley Museum and Library in Wilmington, Connecticut (www.hagley.org) will first be greeted by Modvic's Velocipede Time Machine sculpture — almost a ½ ton of steel, aluminum and metal parts — complete with motorized kinetic movement and LED lighting.

Jill Mackenzie, executive director at the Hagley Museum and Library, reached out to Bruce Rosenbaum at Modvic because they wanted to do a 'super-sized' Steampunk patent model for the lobby of their visitor center that was inspired by their collection.

"Finding the relevant and meaningful objects that would help to tell the story of invention and the connections to the Hagley's patent model collection were our greatest challenges," Rosenbaum said. "Our original inspiration for the



piece included patent models for a velocipede, an electromagnetic Dynamo and Steam Engine Governor Balls."

The permanent exhibit (opening September 2021) honors the creativity and intellectual property of America's inventors. In fact, the U.S. Patent Office has now surpassed 10 million patents issued. Before pages and pages of endless paperwork were required, patent officials asked inventors to submit tiny replica models of the devices and products they wished to build, according to Rosenbaum.

Taking concept drawings from Jim Su, a team of artists, technicians, and welders came together at Salmon Studios in Florence, Massachusetts to work on the sculpture. Sam Ostroff, Brett Kelley and Melanie Rosenbaum all had various roles in bringing the sculpture to life. There is also a tiny replica of the sculpture on display called the "Patently False Patent Model."

The center console is a late 19th Century dental chair with a steam engine device and other metal parts. "The electromagnetic motor was the energy producing piece that actually would produce the power to energize the Velocipede Time Machine," Rosenbaum added.

As the time machine is always a great talking point in steampunk culture, Rosenbaum is currently working on a 'hydro-powered' time machine project which will no doubt contain the same amount of ingenuity and creativity as the Velocipede Time Machine sculpture.

"Steampunk art and design is all about creative problem solving (process of invention), collaboration and resilience. The Velocipede Time Machine was the perfect STEAM (Science, Technology, Engineering, ART and Math) sculpture that brought all those ideas together and will set the bar for future ModVic sculpture projects," Rosenbaum said. **PTE**

Modvic.com



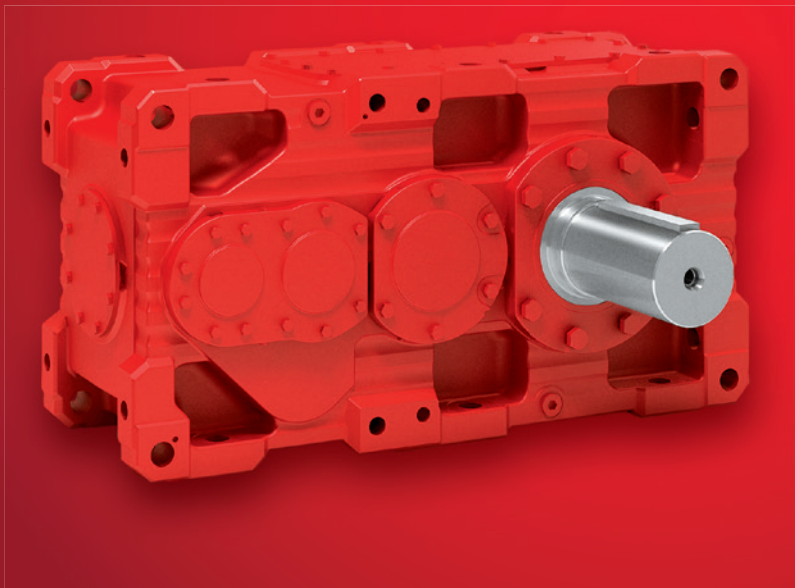


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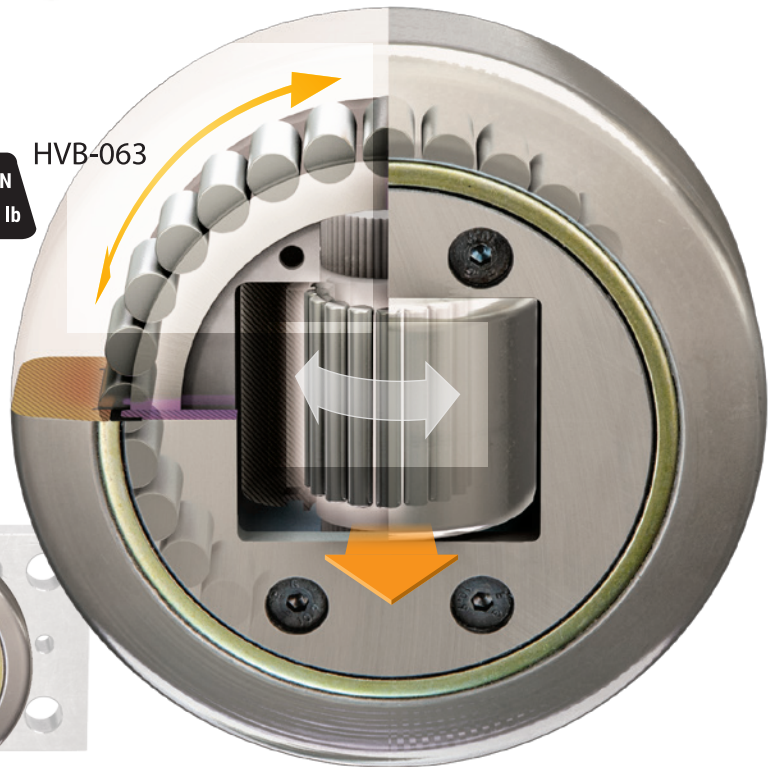
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