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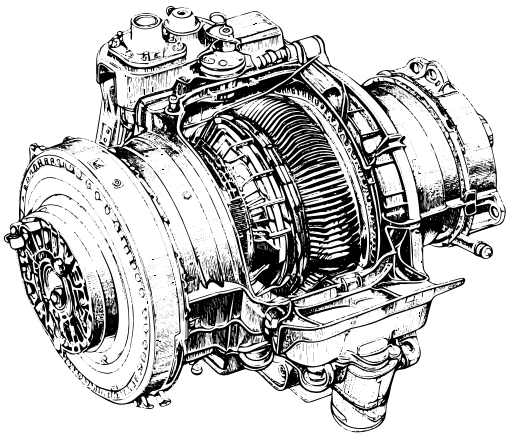

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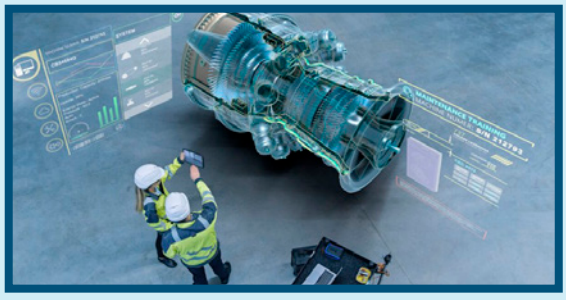
PTE REVOLUTIONS

The Benefits of Bevel Gear Technology

FLSmidth wants to be in constant dialogue with their customers in the mining and minerals industry to develop individual and pioneering solutions for better productivity as well as the responsible and efficient use of natural resources. As the drive is the heart of the crusher, the bevel gear, provided by ATA Gears, is one of its most important components, making gear quality crucial to the design and manufacture of reliable crushers. This means that FLSmidth wants to use only the best and most reliable partners to supply those gears.

powertransmission.com/blogs/l-revolutions/post/9772-the-benefits-of-bevel-gear-technology

Hexagon Examines Four Building Blocks of the Industrial Metaverse



The Industrial metaverse doesn't exist yet but the building blocks are in place—Forrester research report August 2023. It's common to hear the metaverse described as a 3D experience layer of the internet. The "industrial metaverse" is a more difficult concept to define. According to Forrester, it's an umbrella term for a collection of different technologies. Some of those technologies have existed for years just waiting to come together.

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AS SEEN IN GEAR TECHNOLOGY

How Many Speed Ratios for Electric Cars? One Example.

Transmissions are often considered a "necessary evil" in driveline systems. Although often considered cumbersome, transmissions are indispensable when the motor speed does not match the required speed of the machine being driven. Additionally, the efficiency of the driveline can be improved if the overall efficiency—the multiplication of the efficiency of the engine and transmission—of the driveline system comes into focus.

geartechnology.com/articles/30645-how-many-speed-ratios-for-electric-cars-one-example

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

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

Senior Editor
Matthew Jaster
jaster@agma.org

Senior Editor
Aaron Fagan
fagan@agma.org

GRAPHIC DESIGN
Design Manager
Jess Oglesby
oglesby@agma.org

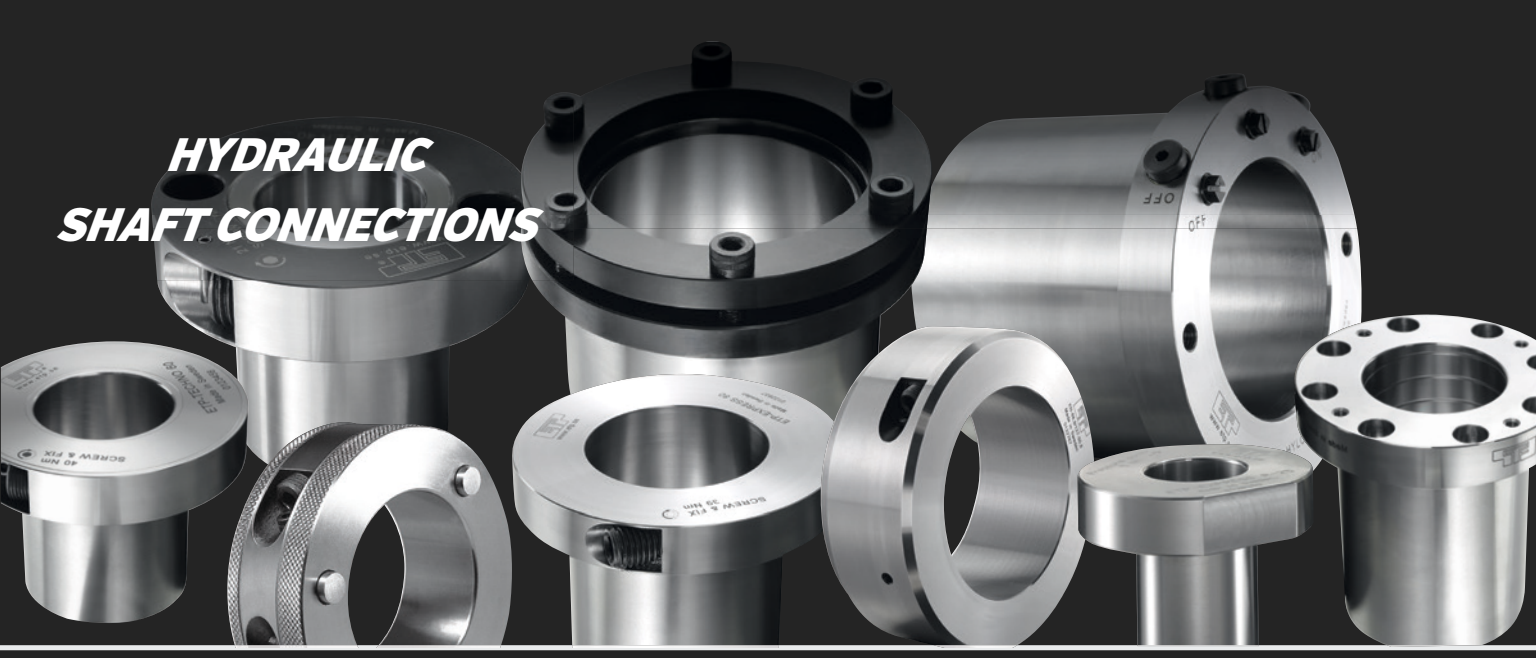
ADVERTISING
Advertising Sales Manager & Associate Publisher
Dave Friedman
friedman@agma.org

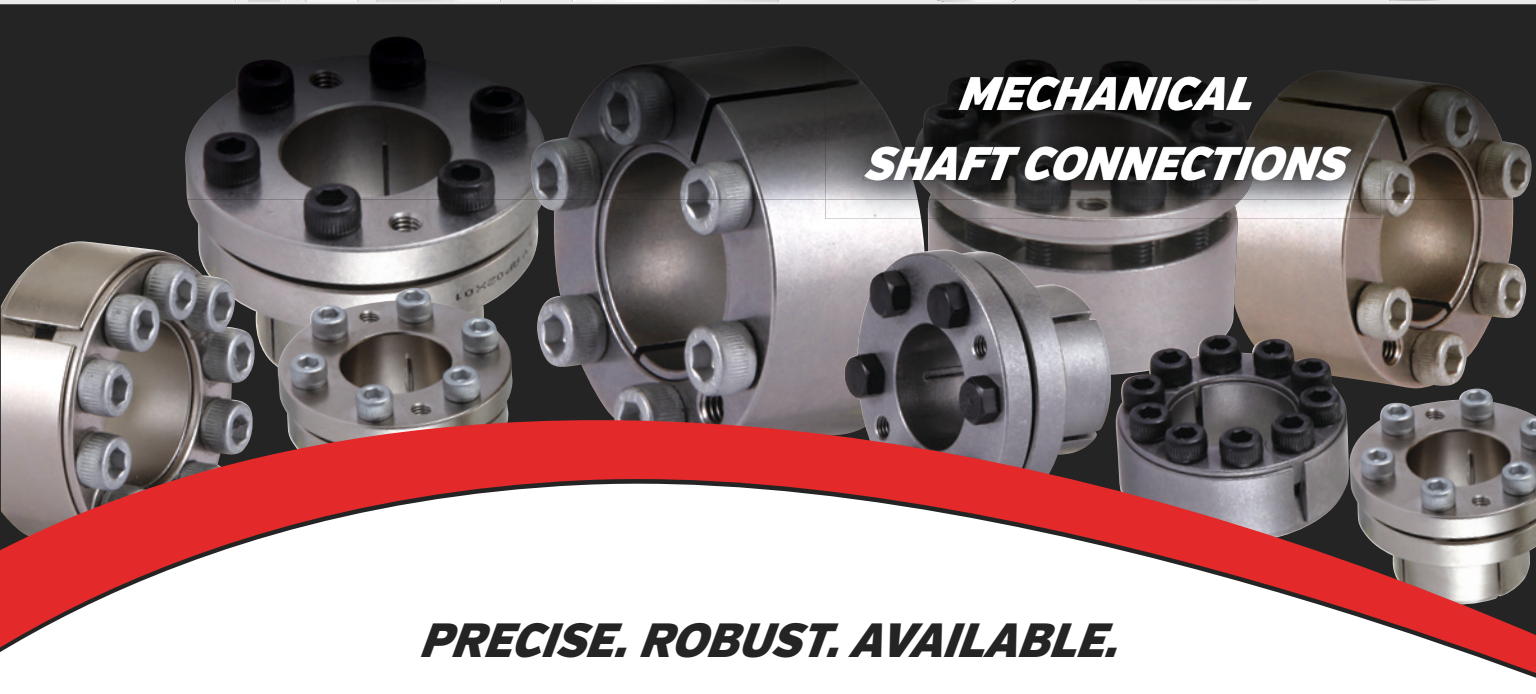
Materials Coordinator
Dorothy Fiandaca
fiandaca@agma.org

CIRCULATION
Circulation Manager
Carol Tratar
tratar@agma.org

MANAGEMENT
President
Matthew Croson
croson@agma.org

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





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FOMO is Real

There's some really cool stuff headed your way, compliments of the editors. We have a lot of great content planned for the next several issues:

- **August 2024**—Focus on Belt and Chain Drives, with an emphasis on heavy industries like Primary Metals, Aggregate/Cement/Asphalt, Pulp & Paper and Chemicals . We've scheduled a piece on specifying gear drives, and we will also include previews of the automation and motion control suppliers who will participate in IMTS.
- **September 2024**—We will focus on Gearmotors, and we'll highlight applications in the aerospace industry. In addition, we're planning an editorial theme of "The Factory of the Future."
- **October 2024**—Our coverage will concentrate heavily on packaging and material handling, including a preview of Pack Expo. We'll also talk about lubrication.
- **December 2024**—Linear Motion, sustainability and the food & beverage industry are all in our lineup for the end of the year. You can expect articles on servo drives, controls, sensors, precision components and energy efficiency.

That's the good news. The bad news is that some of you will never see any of those in-depth, focused articles on the technology and applications of mechanical power transmission and motion control components—because you haven't (YET) renewed your subscription.

If you received a printed copy of this magazine in the mail and the mailing label begins with the letter "X," it means you're on borrowed time. For you, the FOMO is real.

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PTE

Randy Stott
Publisher & Editor-in-Chief

GEAR OILS WITH THE POWER TO PROTECT

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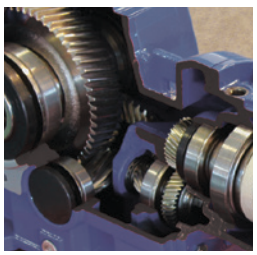

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- These tacky, adhesive, extreme pressure oils cling tenaciously to gear teeth.
- Formulated for heavy equipment and heavy service industrial applications.
- Meets military specification MIL-PRF-2105E and API classification GL-5.

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TSUBAKI NAKASHIMA

Silicon Nitride Balls Offer Advanced Characteristics for Many Applications

Sphere is a symbol of perfection.

For Tsubaki Nakashima, a global company well known today all over the world, the sphere is something more than a symbol: it represents the growth of its company, providing a core business and continuous research through the years to serve customers at its best.

Development

Back in 1913, in Ann Arbor, MI, Leander J. Hoover founded the Hoover Steel Ball Company. In 1990, Tsubaki Nakashima company of Japan acquired the US ball manufacturing company and is currently the biggest manufacturer and supplier of precision balls in the world. Its first markets were the growing automotive and precision bearing industries. More than a century later, the electric vehicles (EV) market is becoming more and more relevant, though the combustible auto industry continues to grow. Its market for high-quality precision products has extended to medical, aerospace, military defense, and critical applications. After the great age of steel, a new era opened wide spaces for more extreme materials which paved the way for ceramics.

Tsubaki Nakashima has nineteen locations globally, among which ceramic specialty division factories are located in the United States, Thailand and Japan. Setting "quality" as the watchword to obtain excellent products for customers, the company constantly improves its know-how and its production processes, updating standards and parameters annually, with strict attention to help ensure quality, starting from suppliers and raw materials.

Silicon Nitride Balls

Ceramic balls can be considered the new frontier in product developments suitable for bearing and high-performance applications. Above all, they are a specialty product line of the company which are commonly used for: hybrid bearings, machine tools, electric motors, fuel injection systems, wind energy and valves.

Ceramic balls are made with aluminum oxide, zirconium oxide and silicon nitride. These components allow great efficiency and high performance. Among ceramic balls, silicon nitride balls (Si_3N_4) have proved to be an ideal solution in many applications because of their advanced characteristics. Silicon nitride ball production specifically helped Tsubaki Nakashima to be well known and present in major EV platforms. The company produces silicon nitride balls in its plants in the United States, in Japan and in Thailand, with a large variety of dimensions suitable for every use (from 0.5 to 86 mm) and with a focused attention to the origin and the quality of its blank materials and to the production process. This is fundamental to offer the best performances to customers.

The Production Process

Ball blanks are sintered ceramic balls. The material is prepared by special processes at very high temperature, pressure on inert atmosphere for reaching highest properties. The result is a spherical shape which is the ball blank. The grinding operation removes the slight belt and small protrusions left on the surface faces, by rolling them between two hard alloy plates under high pressure. The next step is the lapping operation. Flashed balls are rolled between two cast iron plates. One plate is fixed while the other is rotated at a very low speed. The real secret of the extreme quality of precision balls happens here. At this stage the sphericity and size have been established and are carefully inspected according to ASTM F2094 standard and customer requirements. The final production operation is polishing which adds the shiny luster to the finished ball. The balls are inspected visually and/or mechanically.

Top Quality Materials and Best Production Techniques

An excellent performance of silicon nitride balls comes from excellent materials used to make them. Tsubaki Nakashima selects the highest quality rare earth minerals available in the world. The better the rare earth is the better the density of the ball. The higher density generates higher hardness and increases rupture strength which is required to be classified as CLASS 1 per ASTM 2094 standards. Hardness and rupture strength decreases when using a lesser quality rare earth mineral. These are important parameters for customers to evaluate quality, performance, and durability of the balls.

The ball blanks, used at the beginning of the production process, are manufactured utilizing hot isostatic press (HIP) and cold isostatic press (CIP) process. These processes allow the highest quality balls over a large range of sizes. Referring to Tsubaki Nakashima, the company has developed the most

innovated automated method for inspection of silicon nitride balls. This equipment is unique, and it is the result of over 10 years of research and updating to reach the best solution. The new machines automate the inspection process, which reduces overhead, manual human errors and increases output.

Main Properties and Comparisons with Other Materials

Silicon Nitride ceramic balls are remarkable for their ability to perform in extreme conditions.

They show the following several outstanding properties.

- **Resistance to wear and abrasion**
  This makes them ideal for demanding applications.
- **Excellent corrosion resistance**
  Withstands attack from harsh chemicals and demanding environmental conditions.
- **Lightweight**
  Silicon nitride weighs 60 percent less than steel: this benefit reduces centrifugal force, skidding and wear under high speed and acceleration.
- **Antimagnetic and electrically insulating**
  Prevents passage of electric current and arcing.
- **High resistance with low friction**
  Silicon nitride balls mark a low coefficient of friction that enhances wear resistance to enable the bearing to run cooler even under poor lubrication conditions. This means better lubrication, less noise, and lower operating temperatures. That is particularly suitable considering their application in bearings and especially in industries like aerospace, military defense, and hybrid bearings.
- **Temperature hardness and range**
  They can work in high temperatures, retaining their strength and hardness, up to +1,400°C and function at extreme low temperatures. This is due mainly to their hardness and above all to their lower coefficient of thermal expansion, that is only 29 percent of similar steel rolling elements. This means they can be less sensitive to temperature gradients for more accurate preload.
- **Superior surface finish**
  Ra 0.17–0.25 micro-inches may extend L-10 life to as much as 10 times that of steel bearings.
- **Low density, flexural strength, and fracture toughness**
  Silicon Nitride is further characterized by its low density of 3.2 g/cc, high flexural strength of 1.0 GPa, and fracture toughness of 6 MPa/M2. This means higher speeds, less weight, lower inertia, and more rapid starts and stops. Basically, in this way, the bearings can run faster and cooler.
- **Higher modulus of elasticity**
  Elasticity's modulus is 50 percent higher in ceramic rolling elements than in steel ones: this helps increased bearing stiffness and reduced deflection under load to promote reliable performance.

Main Applications

Typical applications include bearings for EV engines and transmissions, electrical vehicle battery, fuel injectors and regulators, high performance racing, space mechanism, critical aircraft parts, high speed instruments, food processing, machine tools, measurement instruments, pumps, and other industries that demand high precision and performance.

tsubaki-nakashima.com

ZERO-MAX

OHLA and CD Couplings Satisfy Critical Electrification Requirements

The recent trend toward electrification minimizes the power requirement needed from internal combustion engines and can sometimes even replace internal combustion engines in a driveline of off-highway equipment. The result is a greener, cleaner, sustainable energy alternative. Electric motors now being designed into mobile equipment have increased the importance of integrating high performance mechanical components like overhung load adaptors and flexible shaft couplings into these new electrified systems.

The reasons for integrating these mechanical components from Zero-Max, Inc.—they provide a precise and easy interface for electrical drives, resulting in cleaner, quieter, safer and efficient motor performance.

With the change to electrified power, there are often challenges integrating mechanical components such as performance requirements, dimensional fit-up, longevity, and other features needed to transition the electric power into the equipment. These challenges are even more prevalent in retrofit applications. Customization may be required to achieve proper fit, speed capacity, and other critical performance features. Zero-Max excels with decades of experience in customizing its solutions to meet the most challenging applications, including those posed by today's electrification requirements.

Zero-Max Overhung Load Adaptors (OHLA) Provide Mechanical System Load Support and Contamination Protection

OHLAs provide both overhung radial and axial load support to protect electrified mobile equipment motors from heavy application loads, extending the lifetime of the motor and alleviating the cost of downtime both from maintenance costs and loss of production. OHLAs also provide a contamination barrier to protect the electrified system from harsh environments

that may include water, dirt, abrasives, chemicals, and other invasive debris, which are often present in mobile equipment applications.

Zero-Max OHLAs are available in an extensive offering of standard models for typical applications, or customized designs to fit applications with unique requirements. Zero-Max notes that well over half of OHLA sales are for customized units.

Zero-Max has a newly expanded standard OHLA product offering, including Extra-Duty designs for extreme applications with high overhung load conditions, high speeds, and high torque loads. Zero-Max also has recently added Double-Male Shaft OHLAs which can handle high radial load capacity for pulleys to achieve belt ratios in applications, or axial loads for spindle-related uses, and are sealed for reliable use in the harshest applications.

In switching to electrified power, the electric motors may have traditional SAE mounting standards typically used on mobile equipment, but may also include NEMA standards, or other non-industry standard mounting dimensions and piloting features. Zero-Max can accommodate these non-SAE mounting challenges with modified / customized OHLA designs.

The latest Extra-Duty OHLA designs feature several carefully chosen enhancements including spherical bearings (standard), enhanced sealing technology, stronger shafts and a longer profile delivering increased operating life, extended load capacities, and higher speed ratings.

While the standard OHLA product line is designed to handle high loads at high operating speeds, the new Extra-Duty models are designed to maximize performance in the most demanding electrified applications. The OHLAs provide a solid, permanent mounting surface for face-mounting or foot-mounting components into the application.

Customized OHLA designs are available for applications with challenging performance, material, and dimensional specifications including vertical shaft mounting orientations. Zero-Max offers a free analysis of any overhung load application to assure proper selection including estimated bearing life, confirming strength of the input shaft connection, and making lubrication recommendations. There is no engineering charge for custom designs and OHLA custom models are available in any quantity from one to hundreds or thousands of units.

For both new and retrofit applications, OHLA models feature exclusive Zero-Max design technology based on decades of field-proven experience in the industry.

Zero-Max CD Couplings Provide Misalignment Protection in Electric Motor Systems

Accounting for shaft misalignment in electric motor systems is equally as critical as in combustion engine-driven systems for mobile equipment. To combat misalignment in these electric motor systems, CD Couplings from Zero-Max provide a high misalignment capacity for parallel, angular, and axial misalignments, while keeping reaction loads low on the connected components. Low reaction loads minimize downtime and increase the lifetime of the system. In addition to high misalignment capacity, CD Couplings also combine high torque capacity and the highest torsional stiffness due to its proprietary composite disc design. CD Couplings also provide electrical isolation between shafts, and alleviate the cost of downtime, maintenance, and loss of production.

Electrified mobile equipment can develop shaft misalignments due to changing load conditions and wear over time. CD Couplings compensate for parallel, angular, and axial shaft misalignments, while keeping sideloads to a minimum, resulting in reduced wear and extended lifetime for both the electric motors and driven components.

Also important, changing to an electrified or partially electrified system often enables downsizing from a larger combustion engine-driven system while retaining needed power and offering desirable operating features. Transitioning to electrified power can be more cost efficient to operate besides being cleaner, quieter, nonpolluting and safer.

Electric motor applications often require uniquely designed shaft couplings for fitting and transitioning electrified power into mobile equipment. Zero-Max is ideally qualified as the premier supplier of custom flexible shaft couplings. The technology of the Composite Disc design together with many decades of experience by Zero-Max Engineers combine to provide a superior solution for the most demanding custom shaft coupling needs.

System designers needing a robust shaft coupling for challenging electrified applications will find Custom CD Couplings from Zero-Max combine high torque capacity, high misalignment capacity, and high torsional stiffness. Custom CD Coupling designs may include couplings handling high power in a smaller package, blind fit couplings, large scale floating shaft couplings, higher misalignment or higher torque designs, higher speed couplings—plus many more.

Editor's Note: Zero-Max utilizes Finite Element Analysis in the design of custom coupling disc packs and reviews various application requirements such as torque, speed, torsional stiffness, misalignment and dimensional fit to ensure a proper design is made for high performance and long lifetime in challenging electrification applications.

zero-max.com

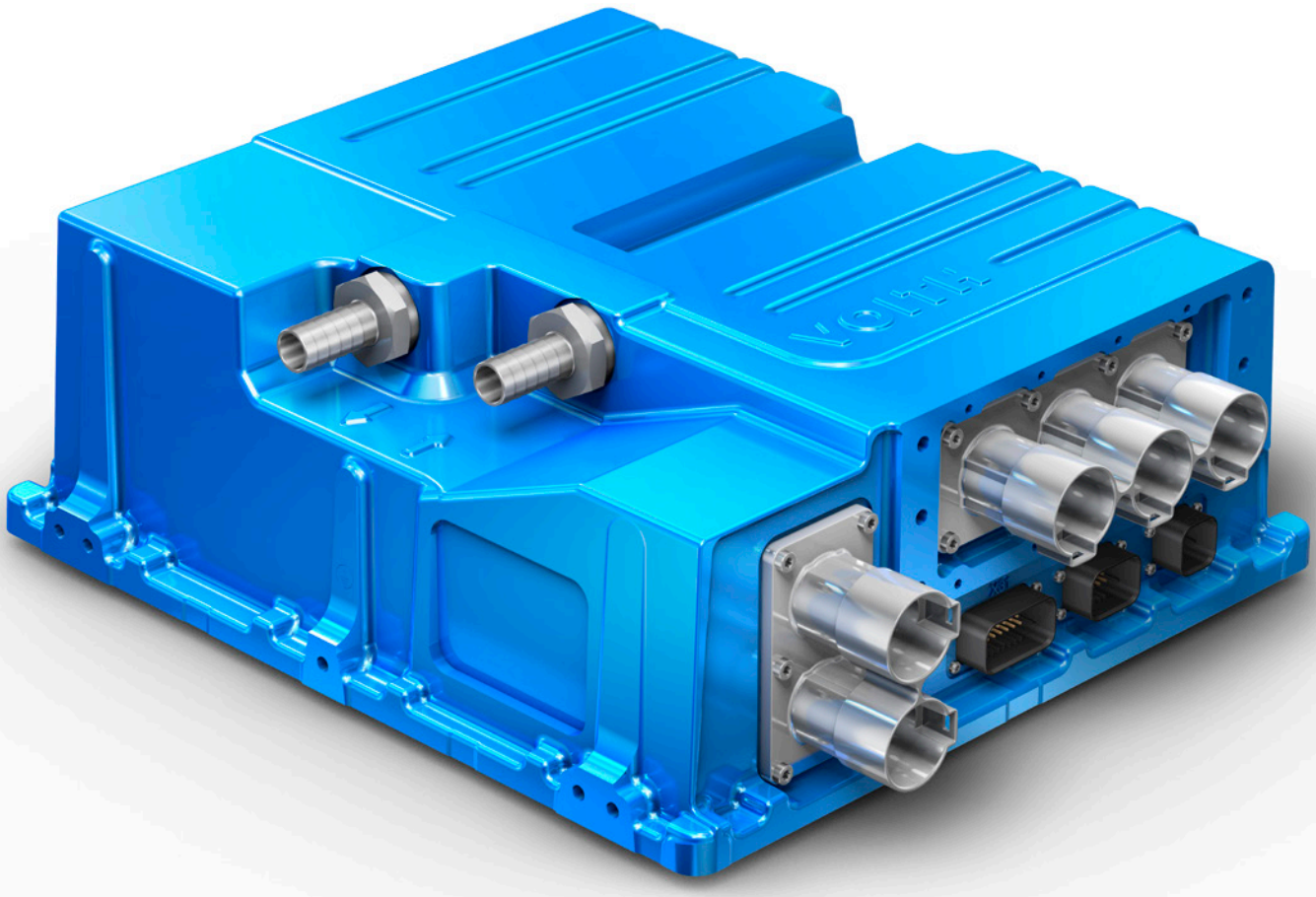
Software and Hardware Advancements for Electrification

Leveraging modularization to address integration and manufacturing challenges related to electrified powertrain systems

Luiz Soares, Director of Sales and Business Development, Voith Turbo

The advancement in the technologies for electrified commercial vehicles combined with government incentives for a more sustainable transportation industry, are driving a boost in the demand and deployment of zero emission technologies.

In the rapidly evolving landscape of electrified powertrain systems for the transportation sector, manufacturers face a myriad of challenges. From meeting stringent regulatory requirements to satisfying customers' demands for performance and efficiency, the industry is under constant pressure to innovate.



The Next Gen Voith Inverter is modularized with four different power levels, from 150 kW to 390 kW, uses AutoSAR software standards, and complies to ISO 21434—Cyber Security and ISO 26262 (ASIL C)—Functional Safety standards.

Additionally, more than any other technology advancement in the commercial vehicle industry in the past, electrification brings the complete symbiose of hardware and software, both equally important elements to the success of the vehicle performance and efficiency. Terms like functional safety, cyber security and others are important parts of the discussions of the development teams at original equipment manufacturers (OEM) and suppliers; researchers; fleets associations; regulatory agencies and government.

One approach that holds significant promise in overcoming these obstacles is modularization of hardware and software. By breaking down complex systems into smaller, interchangeable modules, manufacturers can ensure smooth integration, streamline production processes, enhance flexibility, and improve overall product quality.

Understanding the Software Integration and Hardware Manufacturing Challenges

Before delving into the benefits of modularization, it is crucial to grasp the manufacturing challenges faced by the electrified powertrain sector.

Complexity: Electrified powertrain systems are comprised of numerous components, each with its own specifications and requirements. Coordinating the assembly of these components in a traditional manufacturing setup can be time-consuming and prone to errors. Additionally, electrification also requires software integration, which is extremely important and complex.

Customization: Consumer preferences for electric vehicles vary widely, necessitating flexibility in manufacturing and in software and hardware architecture to accommodate different configurations and features.

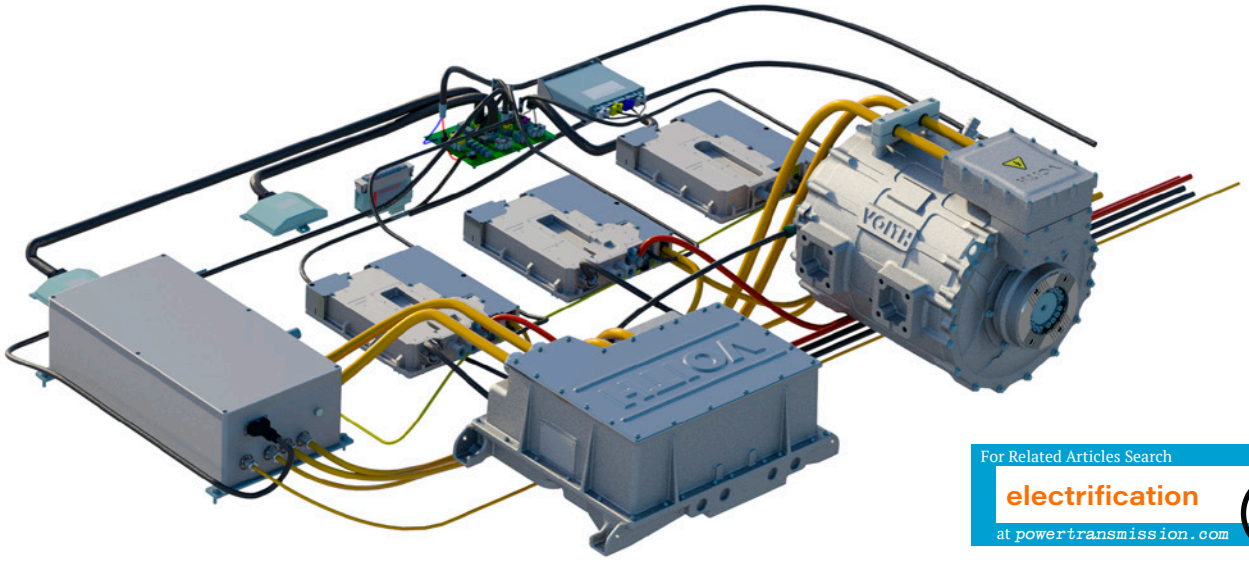
Cost: Developing, manufacturing, and integrating electrified powertrain systems involves significant upfront investments in technology, software and hardware development; and infrastructure. Minimizing costs while maintaining quality is a constant concern for manufacturers.

The Role of Modularization

Modularization offers a strategic approach to address these challenges by reimagining how electrified powertrain systems are designed, integrated, produced, and assembled.

Simplified Assembly Processes: By dividing complex systems into smaller modules, manufacturers can simplify the hardware assembly processes. Each module can be developed and tested independently, reducing the risk of errors, and speeding up production times. Additionally, modularization facilitates parallel production, allowing multiple modules to be manufactured simultaneously, further optimizing efficiency. By considering software architecture modularization, the whole vehicle and its different main control units can be more easily integrated, reducing development costs and timing.

Enhanced Flexibility: Modular hardware and software designs enable greater flexibility to meet diverse customer requirements. Manufacturers can offer a range



Voith Modular Concept (with current inverter design (DIS): Four different e-motors and inverter with four different power levels can be configured with up to three different auxiliary inverters and cables to simplify the hardware and software integration to the different vehicle platforms of the same OEM customer. In total, more than 30 different configurations can be achieved.

of modules with varying features and specifications, allowing customers to customize their vehicles according to their preferences. This flexibility extends to future upgrades and maintenance, as modules can be easily replaced or upgraded without requiring extensive rework.

Scalability and Standardization: Modularization promotes scalability and standardization across production lines. Common interfaces and standardized modules facilitate interoperability between different components, reducing the complexity of integration. Moreover, scalable modular designs can accommodate fluctuations in demand more effectively, enabling manufacturers to adjust production levels as needed without overcommitting resources.

Cost Optimization: While the initial development of modularized hardware and software systems may require additional investment, the long-term benefits in terms of cost savings are significant. Modularization reduces the need for custom-made manufacturing processes for a particular customer and instead allows for economies of scale in production. Moreover, the standardized nature of modules simplifies sourcing and inventory management, further driving down costs.

Case Study: Implementing Modularization in Electrified Powertrains

Voith has embraced modularization for the next generation of inverters.

In this single product, the Voith Inverter can accommodate each of the different electric motors Voith uses varying from 150 kW to 410 kW and from 950 Nm to 3,100 Nm. It can also handle all the different variants of the additional components Voith manufactures for electrified powertrains including high-voltage power distribution boxes (PDB), central electric interfaces (CEI), high voltage cables, control cables, and others, all integrated through *AutoSAR* software standards.

When applied to the vehicle, modularization of the electrified powertrain systems can be achieved by using similar concepts to integrate software and components for different vehicle types (e.g., delivery truck, school bus or yard tractor) and zero emission energy sources, like batteries or fuel cells. Voith simplifies OEMs integration efforts by using more than 80 percent of the same components for both energy sources when comparing similar vehicle applications.

The Road Ahead: Embracing Modularization for Future Success

As the electrified powertrain sector continues to evolve, the adoption of hardware and software modularization will play a crucial role in shaping the industry's future. By leveraging modular hardware designs, manufacturers can overcome production challenges, enhance flexibility, and drive innovation. By leveraging software modular designs, manufacturers can overcome integration challenges, enhance standardization, and reduce cost and time-to-market. However, realizing the full potential of modularization requires collaboration across the entire value chain, from component suppliers (Tier 2 or Tier 3) to vehicle manufacturers (OEMs). By working together to standardize interfaces and develop interoperable modules, stakeholders can unlock new opportunities for efficiency and growth in the electrified transportation sector.

Modularization offers a compelling solution to the vehicle integration and manufacturing challenges facing the electrified powertrain sector. By simplifying integration and assembly processes, enhancing flexibility, promoting scalability, and optimizing costs, modular hardware and software designs enable manufacturers to meet the demands of a rapidly evolving market while driving innovation and sustainability in transportation. As industry players embrace modularization and collaborate to develop standardized solutions, the electrified powertrain sector is poised for continued growth and success in the years to come.

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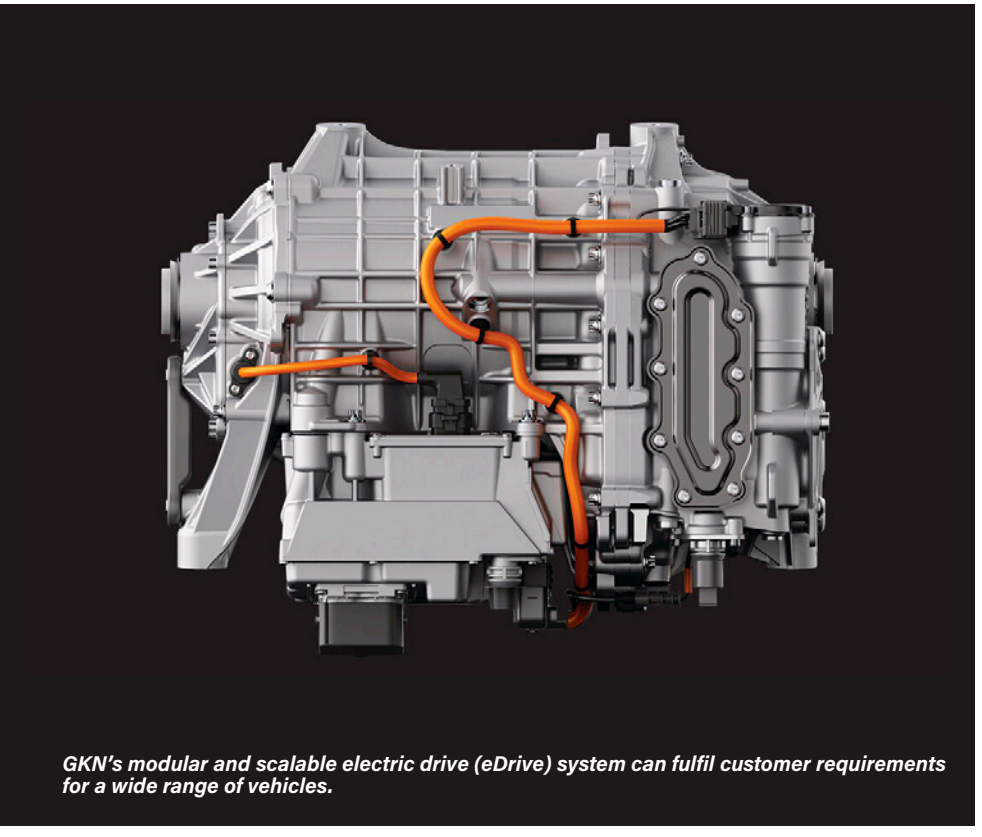
GKN Automotive Focuses on Powertrain Developments for EVs

Examines battery systems, vehicle range and charge speed

Keiwan Kashi, Vice President of Engineering, GKN Automotive



GKN's modular and scalable electric drive (eDrive) system can fulfil customer requirements for a wide range of vehicles.

As the world shifts towards sustainable energy solutions, the demand for electric vehicles (EVs) continues to increase, and at pace. This transition impacts the priorities of those throughout the industry—from OEMs to suppliers—as traditional automotive components are being replaced by electric motors, battery systems, power electronics, and thermal management systems.

For us, as a Tier One supplier, it comes down to making suitable choices. Across the range, we must prudently decide where to add value, which components to manufacture in-house or contract out, and which technologies we want to invest our knowledge and capital into.

At present, the three main areas of focus in the industry are: battery systems and optimizing range and charge speed; the charging system, both inside the vehicle and the charging infrastructure; and the motors and inverters within the driveline.

The question of efficiency feeds into every area of research and development within the EV industry. Efficiency is key to driving greater performance and enhanced sustainability. Put simply, the development and improvement of EVs comes down to its ability to efficiently convert battery energy into miles travelled.

Our key areas of focus are the efficient generation of torque using that energy and transferring that torque to the individual wheels.

Torque generation involves the transformation of energy in the battery into torque in the driveline system. For a battery EV, this consists of the inverter, motor and reducer which convert electrical energy into mechanical.

Inverters convert DC from the batteries into AC current for the motors. While this is a seemingly simple concept, the field of inverters demonstrates the speed at which the industry has needed to move forwards, as research finds new efficiencies and consumer demand evolves. The latest inverters offer a power output increase, as well as an increase in power density and power-to-weight ratio increases. These lead to faster charging times, decreased battery sizes, and improved performance.

More than 10 years ago, inverters typically offered around 110 V technology. Now, the most widely available technology is 400 V, with an increasing number of manufacturers looking to 800 V, and beyond.

As it stands, the adoption of 800 V systems looks to be slower than 400 V systems, due to the costs associated with the Silicon Carbide inverters used for an 800 V system. However, Gallium Nitride could follow Silicon Carbide into the power module market, which could drive down costs and increase capabilities.

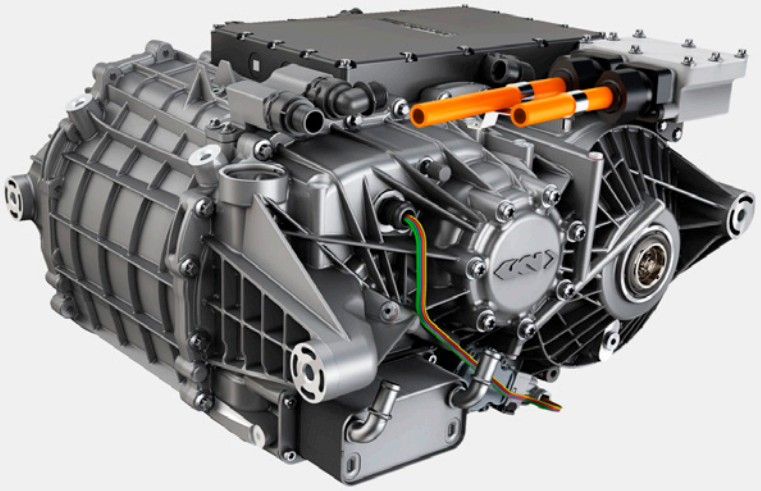
The opportunities and challenges of 800 V systems also impact motor technology. While the rotor design for the most part will be like a 400 V system, it requires—amongst other things—different insulation design on the stator as well as different terminal racks.

Within the torque generation system, the advancement of electric motors is pivotal in enhancing the driving experience, extending range, and accelerating the transition to sustainable transportation.

In recent years, significant progress has been made in EV motor technology, covering everything from efficiency to power density. Motor designs, such as permanent magnet synchronous motors have dominated, utilizing high-strength magnets and winding configurations to achieve higher torque output and efficiency.

Like internal combustion engines, electric motors generate a considerable amount of heat during operation. In EV motors, resistance encountered in the motor generates thermal energy, resulting in a loss of energy in the system through the dissipation of this heat.

To improve the efficiency, longevity, and performance of EV motors,



Efficiency and performance are essential for EV motors. Smaller, lighter packages that offer the same power output as larger units is necessary.

it is essential to reduce and manage these heat losses. As such, we have solutions for active oil-cooled motors that enable delivery of the same power output as larger units, but in a smaller, lighter, more affordable package.

By creating a modular and scalable electric drive (eDrive) system—consisting of the inverter, motor, and reducers (single- or dual-speed)—we can fulfil customer requirements for a wide range of vehicles. We can, for example, use three standardized motors to offer a power range of between 60 and 300 kW, depending on the customer's requirements.

Our second area of focus is around how the torque is managed from the drive unit, distributing it across the vehicle, from front to back, left and right, from axles to wheels.

Higher torques occur in an EV drivetrain because of the instant power availability. Open differentials and limited slip differentials help us to manage this torque and improve traction and control, depending on drive style and conditions.

The initial focus was on open differentials, then mechanical limited slip for enhanced torque transfer, then differential lockers for off-road trucks. We moved into more managed devices that include electronics and software, such as electronic limited slip differentials (eLSD) where the clutch manages each wheel's torque on one axle in a very detailed way, and eventually to twin-clutch all-drive devices for full independent torque transfer to each individual wheel on the axle. eLSDs not only improve the traction and stability of the vehicle, but also significantly improve its agility.

Our last area of focus is on transferring the torque to the wheels. In a standard internal combustion (ICE) vehicle, the power is typically distributed from the engine at the front, across the axle to the wheels.

However, in an EV, rear-wheel or all-wheel drive is favored, meaning that we need to look at the effect this has on drive components as the weight distribution shifts from the front axle to the center.

EV side shafts are significantly shorter than those in ICE vehicles, requiring different mounting points and larger installation angles. As a result, we are seeing increased plunge distances as well as changes to basic requirements for the constant velocity joints (CVJs).

These driveline components must withstand higher vehicle mass, greater acceleration torques, and up to 1,200 Nm of braking force to enable key technologies like regenerative braking. Despite their shorter length, EV side shafts must be stronger and more durable to withstand the vehicle's extra weight, while avoiding a significant increase in size to remain as efficient and cost-effective as possible.

Side shafts play a significant role in transferring torque efficiently from the axle to the wheel. As a rotating part, these parts are often a contributing factor to noise, vibration, and harshness (NVH) performance, to which EVs are particularly sensitive due to their low noise profile compared with ICE-powered vehicles.

It is vital that our product development is sustainable for years to come. As such, across the whole of the product development process, we are looking at developing alternative technologies. One example of this is the development of alternatives to rare earth magnets within the motors, to remove these materials altogether.

Other factors we must consider as we improve and enhance products are the reduction of copper in the motors and inverters, the origins and chemistry of the steels we use, and the lubrication oils and their source.

Not only that, but we must also consider our energy consumption as we produce the parts, ensuring we are continuing to sustainably manufacture driveline components that are fit for the future.

With forecasts indicating that future EVs will have a longer lifetime than today's ICE vehicles, improving durability is essential to the vehicle's longevity. This must be done without compromising efficiency, and crucially without adding even more weight. Therefore, a pragmatic approach favoring balanced system design with the lowest possible material consumption is vital to manufacturing in a way that supports a cleaner, more sustainable future.

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Full Spectrum Supply Chain Solutions at MODEX 2024

A few highlights of the transformative technologies revolutionizing the logistics industry

Aaron Fagan, Senior Editor

MHI's MODEX 2024, held March 11–14 in Atlanta, had a record-shattering number of registered manufacturing and supply chain professionals, reaching a total of 48,733. The event saw attendees, myself included, engaged with 1,200 exhibitors showcasing the latest supply chain technology and innovation across three halls and 580,000 net square feet at the Georgia World Congress Center. This was the largest MODEX event to date, with 32 percent more registered visitors than MODEX 2022.

"From attendance to exhibition space and educational sessions, MODEX 2024 exceeded all expectations, delivering our largest and most comprehensive supply chain event to date," said John Paxton, CEO of MHI, "The success of this event is a testament to the industry's ongoing vitality, dedication to innovation, and delivering world-class solutions for supply chain operations. It was a massive win for the entire industry."

"The excitement on the show floor and the engagement in educational sessions is a sign of the overall power of the supply chain industry and the demand for the latest solutions and technologies in the space," added Daniel McKinnon, EVP of Exhibitions at MHI. "Attendees representing the Fortune 500, the top 100 retailers, and top 100 consumer goods firms brought large teams to MODEX with plans in hand and budgets in place to make large supply chain investments."

The biggest trends at MODEX surrounded digital supply chain solutions including automation, robotics, artificial intelligence, autonomous vehicles, augmented reality, the Internet of Things, and data analytics.

VDG Drum Motors

The drum motor is a one-component conveyor belt drive used for powering belt conveyors in a variety of industries, including airline baggage conveyors, food processing, postal parcel, aggregate, mining, and others. The drum motor is a unique belt drive as there are no external rotating parts.

The input power cable passes through the hollow shaft and is connected to the motor stator. The electric motor is mechanically connected in-line to the gear reducer. The drum motor is partially filled with oil. The oil inside the drum motor lubricates all mechanical components and helps to dissipate heat generated by the electric motor and gear reducer onto the drum, and from the drum to the belt. In theory, the drum motor is cooled by the belt making full contact with the rotating steel drum.

With the motor and gear reducer in-line, the drum motor eliminates mechanical losses, as is the case with traditional external motor and gearbox systems. The only mechanical losses are in the gear reducer itself, which is 2 percent per stage of reduction. The majority of gear reducers in VDG Drum Motors are two-stage, with some having three stages depending on the desired belt speed. As a result, the mechanical losses of the drum motor are kept to a minimum and may range between 4 percent and 6 percent.

However, as compared to traditional external motor and gearbox drives, the drum motor, which offers efficiency, safety, and space savings, has not been all that popular with the belt conveyor industry. Most drum motor failures, regardless of the manufacturer, are related to the inability to extract and dissipate heat generated by the electric motor and the gear reducer. In 2012, the VDG research team began investigating how the lack of heat transfer affects the reliability of the drum motor. To design an electric motor that does not require external cooling, copper and iron losses had to be minimized and electrical and mechanical efficiencies increased. High losses produce high temperatures, and low losses produce low temperatures.

In the new electric motor designs, the laminated stator core and rotor physical size had to be taken into consideration, as well as the length and diameter had to be increased to make up for the horsepower and torque lost by the reduction of the magnetic density. To reduce the operating temperature further, an equalization pressure valve had to be included in the design to prevent pressure build-up in the drum motor. This resulted in significantly increased oil seal service life, substantially better sealing, and reduced oil and motor temperatures.

The VDG engineering team faced a huge challenge in developing and implementing the new motor design. Significant investments along with in-house design and manufacturing of all components, including electric motors and all gear reducers, made it possible for the engineering team at VDG to overcome heat issues experienced with all drum motors when it first entered the market. VDG featured this new generation of VDG Drum Motor designs at MODEX 2024.

vandergraaf.com

New VDG drum-motor designs overcome typical heat issues this type of motor has generally faced.

FANUC America PLC/CNC Motion Controller

Global automation leader FANUC America Corporation unveiled its latest combined PLC/CNC motion controller Power Motion *i*-MODEL A Plus (PM*i*-A Plus) at MODEX 2024 in Atlanta. PM*i*-A Plus unlocks the ability to use FANUC controls for general motion control equipment.

FANUC CRX-10iA fulfillment solution.

The demo at MODEX showed the PM*i*-A Plus controlling FANUC's new Alpha *i*-D Series Servos and Drives to power an automatic storage retrieval system (ASRS) tended by a FANUC CRX-10iA . Visitors saw the PM*i*-A Plus accurately controlling seven axes simultaneously while the collaborative robot bin picked different products.

"This automated storage and retrieval systems (ASRS) demonstration shows FANUC's factory automation and cobot product lines working together to provide a one-stop-shop automation solution to the supply chain industry," says Jon Heddleson, General Manager of FANUC America's Factory Automation. "Our CNC seamlessly integrated with the collaborative robot shows the possibilities for FANUC products to fuel all parts of an automated warehouse cell."

The CRX cobot is integrated via FANUC's Robot ON-SITE, which simplifies the connection of a FANUC cobot or robot to a FANUC CNC. Up to four FANUC cobots or robots can be connected to one FANUC CNC through the platform, which can enable true lights-out production.

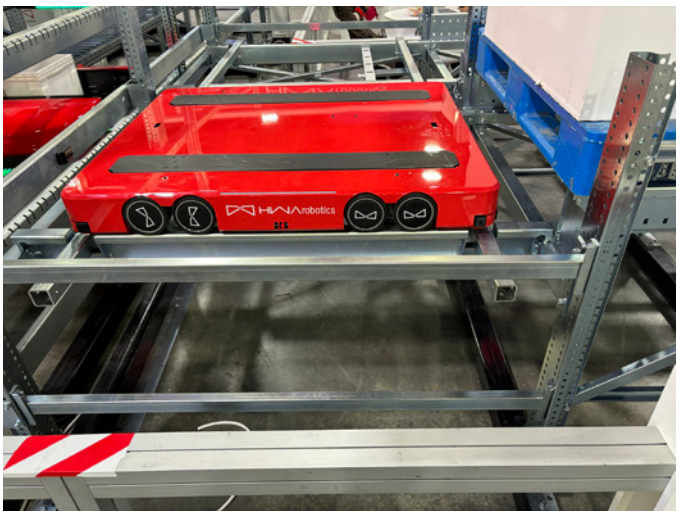
Because the PMi-A Plus is acting as the automated cell's controller, no additional programmable logic controller is needed. Additional FANUC technology featured in this demonstration includes FANUC's new industrial PC *i*PC, which offers a durable touchscreen HMI with faster processing speeds and secure connectivity. The customized graphical screens are achieved by FANUC Picture to ensure simple operability.

The Power Motion *i*-MODEL A Plus can control multiple pieces of industrial equipment as well as run multiple programs simultaneously and independently. A maximum of 32 total control axes can be grouped in up to 10 independent control paths, each path containing a maximum of 24 axes and four axes of simultaneous motion. PM*i*-A Plus' advanced functions enable flexible motion control by using position, speed, torque and/or pressure feedback. Applications perfect for PM*i*-A Plus are controlling machines used for filling, winding, printing, packaging, stamping, and more.

fanucamerica.com

HWArobotics Robotic Shuttles

HWArobotics, a warehousing and logistics robot company with 20 years of experience developing and building shuttle robot systems, introduced its range of automated storage and retrieval systems (ASRS) technology to a North American audience. Designed to optimize logistics and supply chain management operations, four key HWArobotics product lines were launched, including three tote shuttles and one pallet shuttle, as well as associated cargo lifts, racking, and control software.



HWArobotics FPSS1500 pallet shuttle.

HWArobotics' warehouse automation experts were on hand to demonstrate the company's products, which use components from European suppliers, including Siemens (Germany), Voestalpine (Austria), and Hilti (Lichtenstein). The stand featured the SLS300, SLS400, and SLS600 series tote shuttles and the FPSS1500 pallet shuttle.

The FPSS1500 series pallet robot shuttle system is designed for warehouses and distribution centers. The four-directional solution is an advanced ASRS designed for efficient pallet handling and storage, with global standard CE and UL certification. Specialized all-electric shuttle devices are capable of moving in four directions within the racking structure, providing enhanced versatility and operational efficiency.

The FPSS1500A is designed for room temperature environments across the manufacturing, distribution, food & beverage, and industrial sectors, and the FPSS1500B has been created specifically for cold storage, such as food, medicine, and cold chain businesses. Using AI scheduling algorithms, it has achieved swarm intelligence within the

PSR system to automatically adjust efficiency based on the number of vehicles and the rack structure.

Alongside its high-performance shuttle devices, HWArobotics has a wide portfolio of goods lifts, racking and picking workstations (including robotic picking), for maximum performance and conveying capacity, high positioning accuracy, and sturdy, high tolerance storage.

hwarobotics.com

LG CLOi CarryBot

LG Business Solutions USA created a warehouse efficiency and flexibility solution with the new LG CLOi CarryBot family of autonomous mobile robots (AMRs) designed to intelligently navigate complex floor plans to move and deliver payloads in customizable configurations, with loading and unloading performed by workers.

LG CLOi CarryBot is an autonomous mobile robot (AMR).

LG CLOi CarryBot was officially launched in the United States at the MODEX. LG also previewed P5G, the company's private 5G technology under development for dedicated robot networks supporting reliable, stable performance. Development of the new LG P5G network is leveraging the vast technical resources and deep expertise of global innovator LG Electronics.

"The new LG CLOi CarryBot can immediately begin solving warehouse inefficiencies by providing on-time movements and consistent, reliable operation that allows workers to stay within their zones and increase productivity," said Tom Bingham, Senior Director, LG Business Solutions USA. "CLOi CarryBot offers seamless package movement and delivery within a warehouse and eliminates the need for workers to physically transport packages."

Having already launched autonomous robots that transport products, guide customers, deliver food and beverages, and provide information in commercial settings, LG is now expanding its robotic line to "help provide true solutions for warehouses of any size by reducing lead times and enhancing efficiency," Bingham explained.

Featuring LG's advanced AMR platform for autonomous navigation, the latest Wi-Fi capabilities, ergonomic hardware design, an intuitive fleet management system, and an efficiency-boosting material control system that optimizes order distribution and scheduling, the LG CLOi CarryBot can streamline product movement and adjust to real-world situations while reducing physical strain on workers.

With a top speed of 2.7 miles per hour, a typical runtime of 18.5 hours and autonomous dock charging in 6 hours, LG CLOi CarryBot is a powerhouse for delivering small-to-medium packages across virtually any distance. These powerful hardware capabilities combine with cutting-edge software and machine learning for seamless integration with various facets of Warehouse Management Systems, including material control, fleet management, and robot management systems.

Interfacing with material control systems enables smart order grouping, picking item categorization, order information distribution, and total picking cooperation support including notations of shortages or skipped items. Fleet management system integration provides path-planning for multi-AMR users, intelligent AMR fleet navigation and prioritization, traffic balancing and detouring, obstacle avoidance, and automated return for dock charging. On the backend, the robot management system provides managers instant access to location info, AMR status, alerts for abnormal interactions and statistical data to support decision-making.

"LG CLOi robots have already proven their navigation and automation prowess in a variety of industries and environments, and now warehouse owners and managers can shift their operations to more automated routines to improve efficiency and enhance daily productivity," Bingham said.

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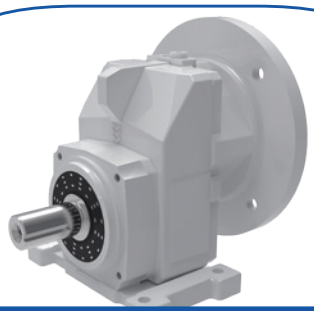

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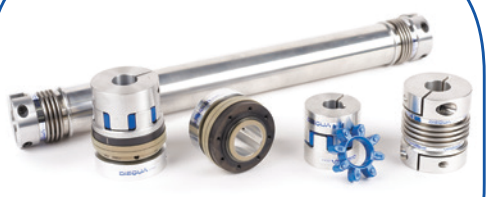

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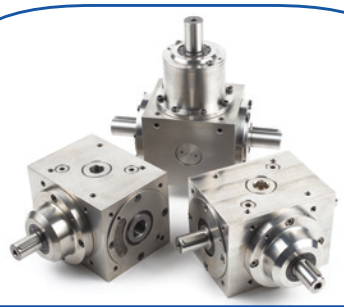

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The Benefits of Bevel Gear Technology

ATA Gears collaborates with FLSmidth to successfully keep mining equipment running efficiently

Matthew Jaster, Senior Editor

The Danish company FLSmidth wants to be in constant dialogue with their customers in the mining and minerals industry to develop individual and pioneering solutions for better productivity as well as the responsible and efficient use of natural resources. As the drive is the heart of the crusher, the bevel gear is one of its most important components, making gear quality crucial to the design and manufacture of reliable crushers. This means that FLSmidth wants to use only the best and most reliable partners to supply those gears.

"ATA Gears has been working together with FLSmidth since the 1990's and we have developed new bevel gear designs for several crusher types over the years," said Pentti Hallila, sales manager at ATA Gears.

Hallila said ATA Gears supports its customer base on bevel gear design daily examining everything from efficiency and reliability to performance and assembly. "High power transmission efficiency without big energy losses is always desired, but the top priority is reliability."

Understandable, seeing that these bevel gears need to operate effectively—under a full load with an ideal tooth contact pattern—in harsh environments for an extended period.

ATA Gears has worked closely with FLSmidth on bevel gear design for mining operations for several years. (Courtesy ATA Gears)

History of Bevel Gears/ Gyratory Crusher

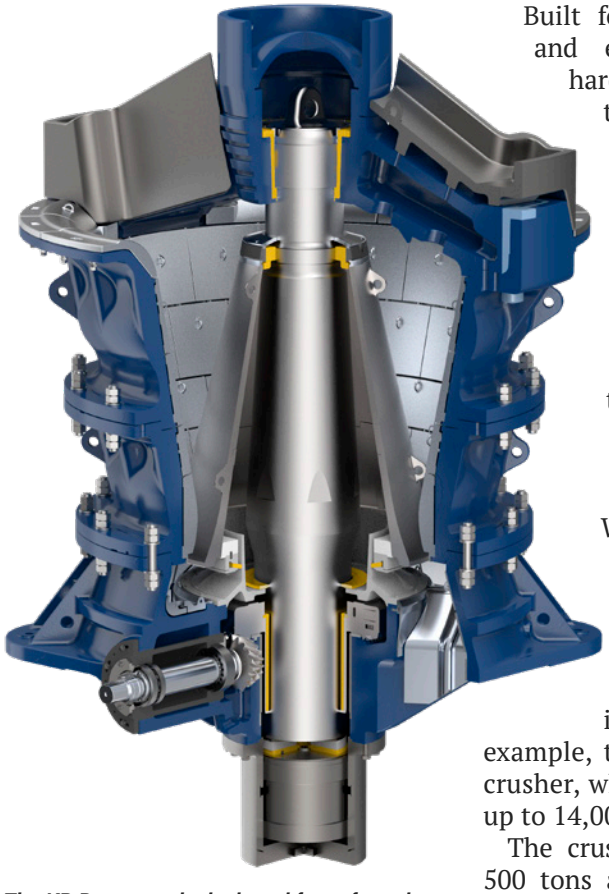
Compared to straight-toothed gears, the advantage of spiral bevel gears is smoother and more gradual tooth engagement. This not only reduces noise but also the impact stress on the teeth. Moreover, spiral bevel gears, unlike straight-toothed gears, don't break under heavy load or at high speed. The first ATA spiral bevel gear was manufactured in 1940. Since then, these specially designed, spiral-toothed gears have become renowned for their superior power transmission capability. Today, ATA spiral bevel gears and bevel gear systems are utilized in marine, industrial and heavy engineering applications that must have high-quality. ATA can produce gears from 50 mm to up to 3,000 mm in diameter—and the optimal unit solution for any requirement.

A gyratory crusher is a machine designed to reduce the size of Run of Mine (ROM) large rocks to smaller rocks, gravel, sand, or rock dust; this is essential for efficient transport of the ore via conveyors etc. (*savree.com*) Crushing is the first of many

stages that lead to separation of the ore from the waste (gangue) material. Waste material can be discarded or recycled allowing the ore rich stream to be further processed at the main plant.

Various types of crushers and mineral separators may be employed depending upon the throughput, hardness, and properties of the ore being processed. In all cases, the crushing stage is essentially achieved by transferring a mechanically amplified force (via mechanical advantage) to a material, to breakdown the bonds which hold the material together.

Gyratory crushers were invented by Charles Brown in 1877 and further developed by Gates in 1881 (they were commonly referred to as "Gate's crushers" in the early years). A primary crusher is designed to receive ROM rocks directly from the mines. Gyratory crushers typically crush to reduce the size of aggregate to a maximum of about one-tenth of its original size.



The KB Pro range is designed for safe and easy maintenance, high performance, and high throughput rates.

FLSmidth Crushers

FLSmidth's commitment to optimizing quality crushers dates to the Traylor and Fuller-Traylor gyratory crushers of the early 1900s. Since then, these crushers have continuously withstood the harshest demands of the world's mines and rock quarries. Through constant improvements in engineering, the company has earned a reputation as a proven and preferred crusher supplier throughout the mining industry.

FLSmidth's Gyratory Crusher Pro series has more than 80+ installations around the globe, operating successfully in all climate zones. This crusher series is designed for high performance and, at the same time, cost-effective operation with low servicing and maintenance costs. The Gyratory Crusher Pro offers customers high-performance crushing operations under toughest conditions from -40°C to 50°C—whether it is the heat of the Australian summer or the cold of the Norwegian winter.

Built for ultimate performance and easy maintenance, this hard rock crusher excels at the crushing of medium hard to hard rock and ore in semi-mobile and stationary processing plants in ore mines and in the natural rock industry. FLSmidth focuses on performance, reliability, and cost-effectiveness in these mining operations.

Upgrading Operations

Working with ATA Gears, FLSmidth has achieved remarkable operative success in the power transmission applications of the mining sector—producing, for example, the new 63-130 gyratory crusher, which has a throughput of up to 14,000 tons per hour.

The crusher itself weighs nearly 500 tons and the diameter of the bevel gears delivered by ATA is impressive, 2.4 m. The shape of the teeth, the meshing behavior and materials have been developed over the years together with ATA´s Gear Doctors in close and highly professional cooperation.

Through the continuous cooperative development over the years, the new bevel gear design allows the installation of higher motor power for the same size of crusher, resulting in higher throughput rates. This helps FLSmidth's customers achieve more efficient energy consumption without needing upgrades or new machines to achieve the same throughput. Moreover, the 63-160 gyratory crusher, which is among the world's biggest gyratory crushers—if not the biggest—offers major savings in maintenance time and costs.

Christian Wibbels, head of purchasing, expediting and inspection (Germany) at FLSmidth is very happy about the cooperation between his company and ATA Gears.

"Thanks to ATA's gear design, in service situations, the pinions can be assembled and disassembled without moving gear wheels axially. This feature has reduced assembly time of our gear drives by more than 50 percent. Also, downtime due to maintenance at mining sites has been significantly reduced," Wibbels said.

Tooth stress distribution, dynamic behavior, sliding speeds, flank temperatures and tooth backlash are all important considerations to optimizing crushers and other mining equipment. These demanding conditions require dependable and sustainable gears for record-breaking operating times and quality rates.

"In the future we will see larger power transmission capacity, increased gear size, higher accuracy, optimizations, high grade materials, reliability, and more stringent quality assurance," Hallila added.

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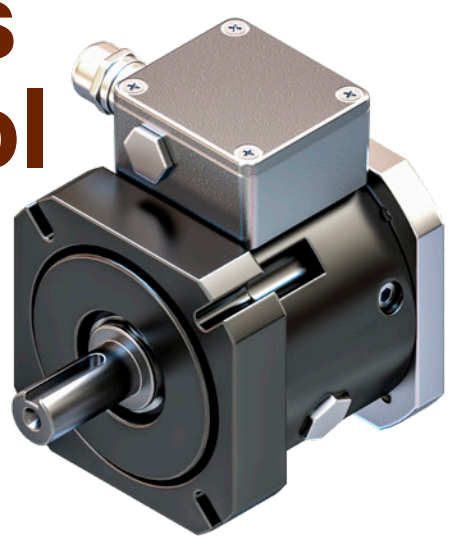
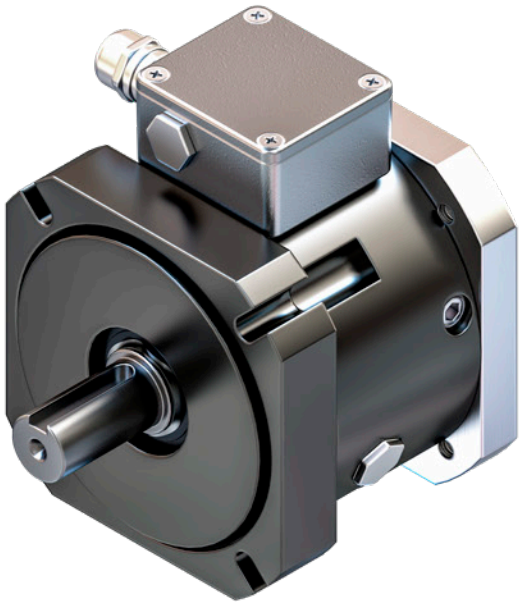
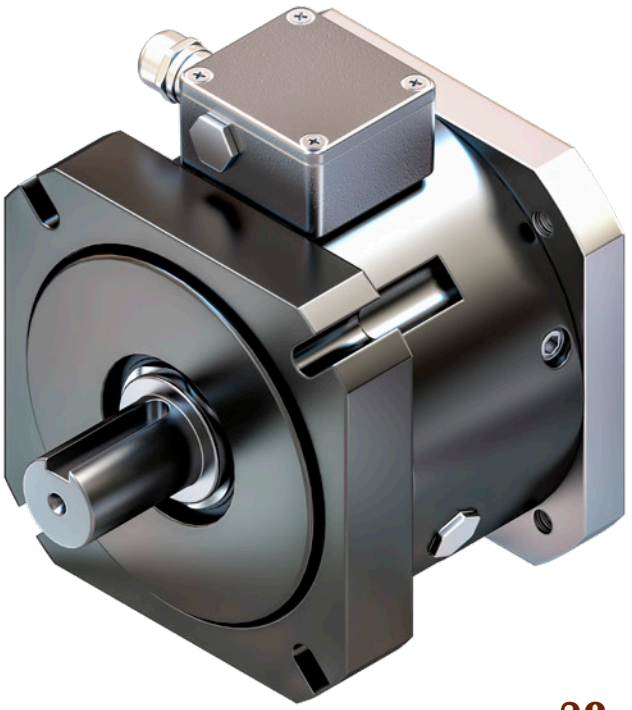
New Innovations in Motion Control

Nexen designs braking solution with zero backlash up to the full holding torque in a rigid, easy to install product

Matthew Jaster, Senior Editor







Previous discussions with engineers at Nexen examined the challenges and increased complexity of components for machine designers in industrial machinery.

"Historically, Nexen Group's product offerings were mechanical and pneumatic solutions, including clutches, brakes, torque limiters, and coupling products for industrial machinery that needed to control power transmission," said Justin Zollner, design engineer at Nexen. "As Nexen expanded into precision motion control applications, the need for zero backlash drive solutions became increasingly important. In addition, many motion control applications are limited to only electric drive solutions. These two overlapping needs were the driving force of the Evolve Electric Servomotor Brake line."

Functional Safety

System stiffness and rigidity, in addition to torque requirements, are primary factors in selecting a servo system brake solution. Functional safety is becoming a key factor in the decision-making process, which focuses the system designer on a solution's B10 and B10d ratings to ensure it meets the overall design intent.

Functional safety is about reducing the risk of human injury or death posed by the use of machinery in the face of operator error or mechanical failure. Building functional safety requires the design and fabrication of protective features that mitigate against the threat of worker injury. Protection systems should be designed to respond to human errors, hardware failures, operational or environmental stress.

Nexen understands that functional safety standards and industry requirements are evolving. The focus is to provide more safety focused components for machine builders. Functional safety is, in fact, becoming more prevalent. The need for monitoring and diagnosing problems thru internal machine trouble shooting will be vital as factories become more and more automated.

Sizing and Selecting a Brake Solution

Nexen engineers collaborate with customers to size and recommend solutions using all the products in Nexen's extensive catalog, including the newly released Evolve line.

Nexen's Evolve Electric Servomotor Brake Specifications

- 100 mm, 125 mm and 155 mm frame sizes available
- Easily mounts between a servo/ stepper motor and a gearbox
- Spring engaged – electrically released
- Two friction interfaces for increased torque
- Zero Backlash via flex disc and rotor
- Double Row Angular Contact Bearing
- Shaft with integrated clamp collar
- 24 VDC standard coil
- Fast delivery times
- Made in the USA

"If a customer cannot find the exact solution on our website, Nexen engineers will help select the appropriate product. A custom solution can be discussed and engineered if a product is not currently available in Nexen's group catalog," Zollner said.

The Evolve Electric Servomotor Brake line is spring engaged and electrically released, engineered with a double-sided friction interface for increased torque capacity. The double row angular contact bearing delivers overhung load capacity and rigidity allowing machine builders and OEMs to design a more robust machine. The brakes can easily be configured to match the motor and gearhead mating interfaces.

Manufactured in Webster, WI., the Evolve Electric Servomotor Brake has fast delivery times, allowing for minimal downtime in designing and maintaining machines.

"The application challenge required a zero-backlash stand-alone product that could be incorporated into an existing system. The Evolve line was engineered and sized to fit with most manufacturers' standard motor offerings. The Evolve servomotor brake can be incorporated into a system using the existing servomotor and gear reducer with minimal effort," Zollner said.

The Evolve series of servomotor brakes is set to be leading-edge brake solution offering high-end rigidity, torque, and zero backlash in a very simple-to-install and reliable package. Fewer parts equal a much more reliable product that machine builders and maintenance staff can rely on.

"Robotics, machine tools, assembly, and packaging will be the biggest users of the Evolve servomotor brake. However, any axis that is driven by a servomotor is an excellent candidate for benefiting from the new Evolve servomotor brake," Zollner added.

Enhanced Website Options

Nexen Group works with customers to design a product that meets their application needs.

"We have an extensive catalog of standard products. Still, we also do a lot of custom designs and manufacture those products to meet the needs of engineers, machine builders, and maintenance workers," Zollner said.

Additionally, the Nexen Group launched a new website in 2023, designed to offer an intuitive, user-friendly experience with improved navigation, search, and responsiveness while allowing customers to see the full range of products. It allows engineers, repair technicians, and specifiers to easily find the Nexen product that is needed for their application and processes.

Features include:

- Look ahead navigation. Significantly reduces the number of clicks it will take to find the necessary Nexen product.
- Product selection tool. Enhanced filtering options make it easy to narrow down products for an application or design.
- Streamlined store and checkout. Registered users can easily order products and see past orders.
- Full documentation library. Complete sets of CAD drawings (PDF, STEP, and DXF), technical data sheets, and user manuals for every product are available for download.
- Contacting Nexen Group. Easily connect with Nexen's engineers to help with a design, product, or custom configuration.

Additional Capabilities

After numerous customer requests for a Nexen electric servomotor brake, the company answered these requests by designing a brake with zero backlash for precision holding, low inertia, and a double-sided friction rotor that creates two friction interfaces for increased torque capacity.

Zollner said the Evolve platform will be introduced into various configurations and solutions for different applications.

"In the near future, the Evolve servomotor brake will be incorporated into many different Precision Motion Control products that Nexen Group offers. This will give machine builders and maintenance personnel an additional trusted Nexen product that they can incorporate into their processes."

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Advanced Distortion Control for Case Hardening of Transmission Components

Volker Heuer, David Bolton, Jochen Friedel, and Orlando Garcia

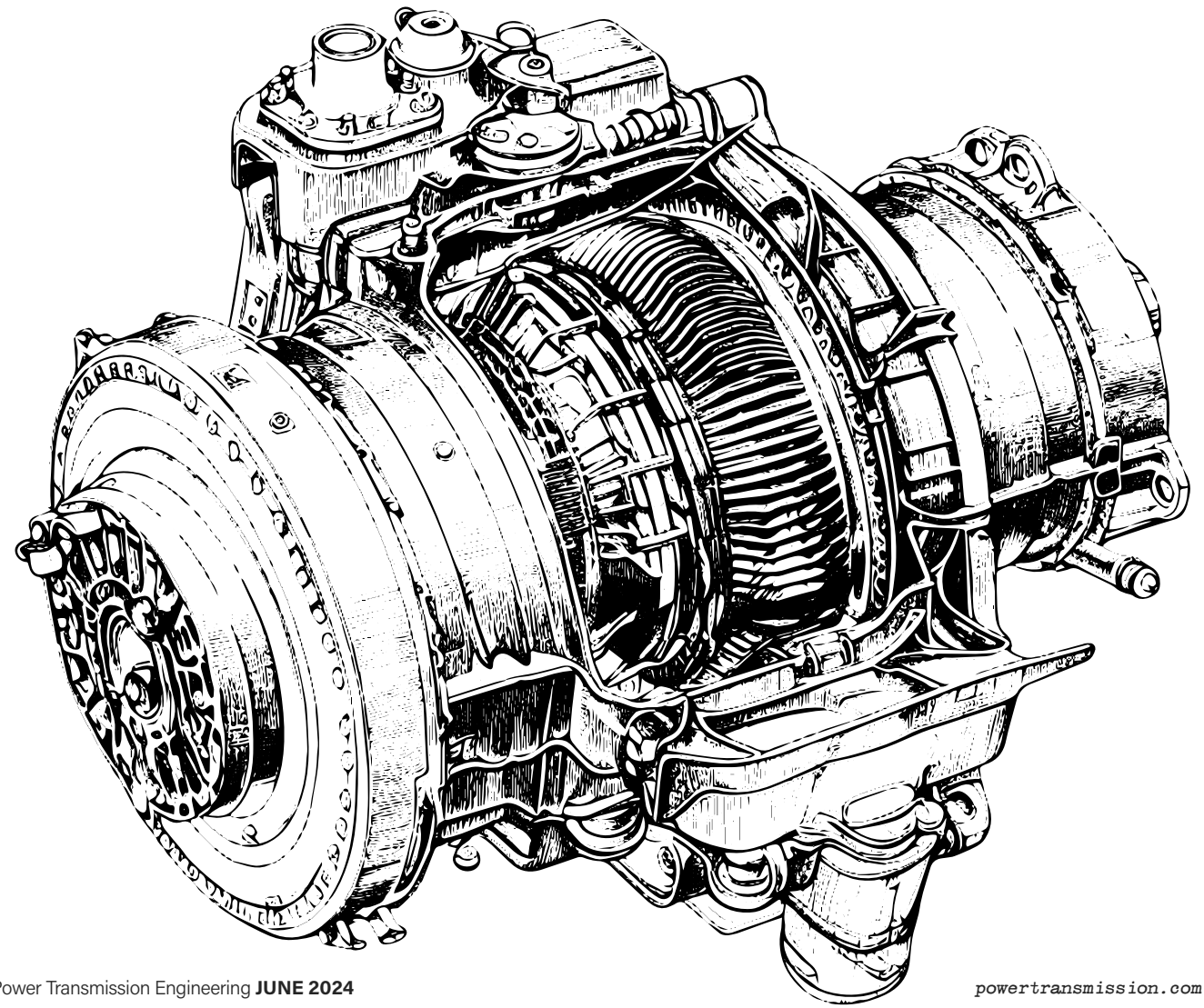
Introduction

Distortion control is one of the major challenges in modern manufacturing. Distorted gear components cause noise in the transmission and may even create problems during transmission assembly. Especially battery-operated electric vehicles (BEV) and other electrified vehicles (such as Hybrids) require a low-noise transmission with high-precision components.

Distortion has a strong cost impact because distorted components often need hard machining after heat treatment. Better control of distortion means:

- less cycle time per part in hard machining,
- less hard-machining capacity needed, and
- less tooling cost for hard machining.

With excellent control of distortion for some applications, hard machining can be eliminated. For some other applications, the need for a cost-intensive press quench can be eliminated if excellent distortion control is established.



Distortion Mechanisms

The plastic deformation of metallic components during heat treatment is called distortion. Distortion occurs if the stress in the material exceeds the yield stress of the material. During case hardening the components are exposed to high temperatures ranging from 880°C to 1.050°C and the yield stress decreases strongly with increasing temperature of a component. Three different types of stress in the material need to be distinguished:

- Residual stresses (they are induced before heat treatment by casting, forging, machining, etc. [Ref. 1]).
- Thermal stresses (they are caused by the temperature gradient while heating and quenching).
- Transformation stresses (they are caused by the transformation from ferrite to austenite during heating and transformation from austenite to martensite/bainite during quenching).

These three types of stresses overlay with each other and add up to the total stress in the component. They are influenced by part geometry, steel grade, casting, forging, machining, etc. and they are influenced by heat treatment. If the total stress in the component exceeds the yield stress, then plastic deformation (distortion) of the component takes place. The chronology and the height of the three types of stresses leading to distortion are dependent on numerous influencing factors, see Figure 1.

When analyzing distortion, it should be distinguished between size change and form change. Size change refers to the homogenous growth or shrinkage of the treated component while maintaining its shape (e.g., the homogenous growth or shrinkage of the diameter or the length of the component). Form change refers to a change in the shape of the part (e.g., roundness of a gear, bending of a gear shaft, or deformation of gear tooth geometry).

All carburized components will have some size change due to a transformation in the microstructure from ferrite into martensite. The size change must be controlled with green machining. For example, if an outside diameter grows 10 microns during heat treatment, it should be machined 10 microns smaller before heat treatment.

There are many different characteristics impacted by form change. However, it helps to better understand form change by simplifying distortion into the two main parameters flatness and roundness.

Form-change for shafts is mainly straightness. When analyzing gears, flatness can be determined by the amount of "helix variation," or "lead variation." Roundness is a measurement of "circularity."

The helix average also changes during heat treatment. The helix average changes in a minus direction, meaning the tooth is unwinding. For instance, the helix angle might be 15 degrees in the green state, but it may change to 14 degrees after heat treatment. This must be compensated for with green machining.

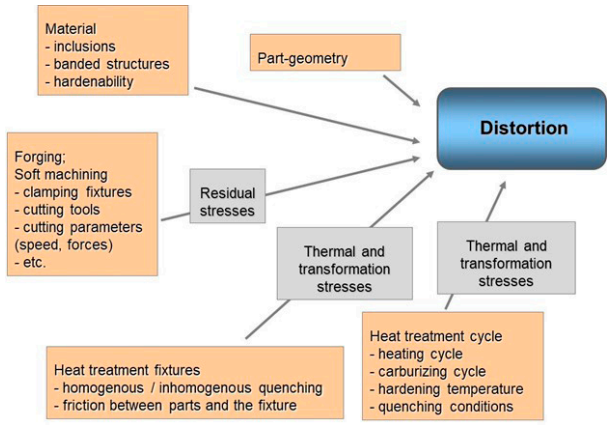


Figure 1—Factors influencing distortion.

Low-Pressure Carburizing in Combination with High-Pressure Gas Quenching

Heat treatment distortion can be significantly reduced by applying the technology of Low-Pressure Carburizing (LPC) and High-Pressure Gas Quenching (HPGQ). LPC is a case-hardening process performed at a pressure of only a few millibars using acetylene as the carbon source. During HPGQ the load is quenched using an inert gas stream instead of a liquid quenching media. Usually, nitrogen or helium are used as quench gas (Refs. 2, 3, 4).

HPGQ offers significant potential to reduce heat treatment distortion. Conventional quenching technologies such as oil or polymer quenching exhibit nonhomogeneous cooling conditions. Three different mechanisms occur during conventional liquid quenching: film-boiling, bubble-boiling, and convection. Resulting from these three mechanisms, the distribution of the local heat transfer coefficients on the surface of the component is very nonhomogeneous. These nonhomogeneous cooling conditions cause high thermal and transformation stresses in the component and subsequently distortion. During HPGQ only convection takes place which results in much more homogenous cooling-conditions, see Figure 2 (Refs. 5, 6). Significant reductions of distortion by substituting Oil-quench with HPGQ have been published (Refs. 7, 8).

Another advantage of HPGQ is the possibility to adjust the quench intensity exactly to the needed severity by choosing quench pressure and quench velocity. Typical quench pressures range from 2 bar to 20 bar. The gas velocity is controlled by a frequency converter. Typical gas velocities range from 2 m/s to 20 m/s. Quench pressure and gas velocity are chosen depending on the part geometry and the steel grade of the component to achieve optimum results.

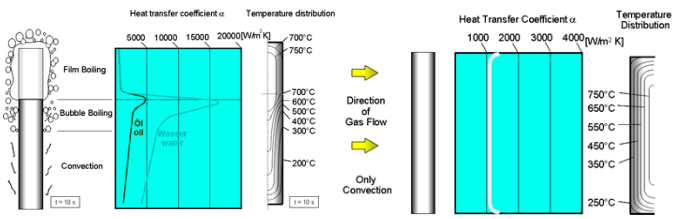


Figure 2—Heat transfer coefficient and temperature-distribution in liquid- and gas-quenching (Ref. 5).

The following equation describes the heat transfer coefficient as a function of gas velocity, density, and type (Ref. 2).

$$\alpha = C \cdot w^{0,7} \rho^{0,7} d^{-0,3} \eta^{-0,39} c_p^{0,31} \lambda^{0,69}$$

where

C	is	constant factor (depending on quench cell)
w	is	gas velocity
ρ	is	gas density
d	is	diameter of component
η	is	viscosity of the gas
c_p	is	specific heat capacity of the gas and
λ	is	thermal conductivity of the gas.

Typical gases applied for HPGQ are nitrogen and helium (Ref. 2). To achieve the required core hardness in gears of low alloyed case hardening steels, helium as a quenching medium and a gas pressure of 20 bar is necessary for many applications.

For many applications it is not the absolute height of distortion causing manufacturing problems but the spread of distortion. The spread of distortion cannot be compensated with green machining. So, for many applications, the challenge is to optimize the HPGQ in such a way that it provides a heat treatment process with very little variation of distortion within a load and over time from load to load.

Strategies for Distortion Control When Applying HPGQ

As described above, the gas quenching process offers two major advantages when compared to liquid quenching in terms of distortion control:

- More homogenous heat transfer coefficient around the surface of the quenched component.
- The flexibility to tailor the quench intensity specifically for the needs of the quenched component.

To fully exploit the benefits of HPGQ it is important to optimize the design of the heat treatment fixtures. The fixture should provide a horizontal loading of the components and should allow a homogenous gas flow around the treated components during quenching as much as possible. Figure 3 shows an example of a fixture made of carbon-reinforced carbon (CFC).

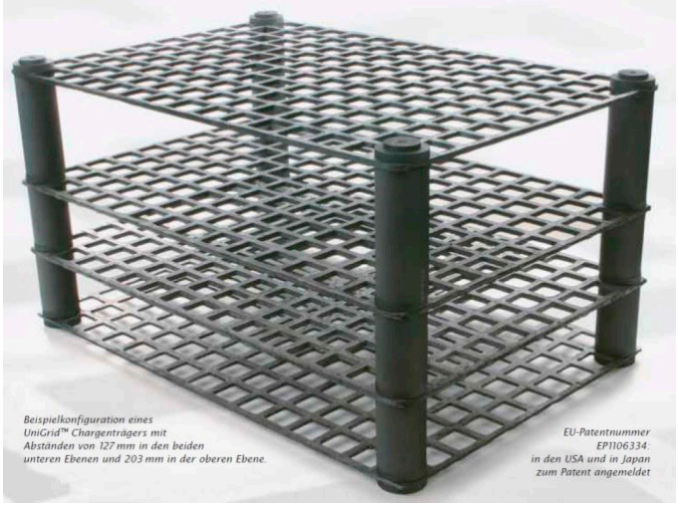


Figure 3—Fixture made of CFC (Source: Schunk GmbH).

In addition, the HPGQ—process offers more options for further reduction of heat treatment distortion. These process modifications are explained in the following.

Dynamic Quenching

Dynamic Quenching is a process where the quenching parameters gas pressure and/or gas flow velocity are stepwise varied during quenching, see Figure 4. This process is typically divided into three steps (Ref. 9):

1. High quenching severity until a certain part temperature is reached.
2. Quenching severity is reduced for a set time to allow for temperature equalization in the part.
3. Quenching severity is increased again until the end of the quenching process.

The control system in the quenching chamber allows to control the different quenching steps of "dynamic quenching" in a very accurate way with good reproducibility. Optimum results are achieved when using helium. The light-quenching gas helium can be decelerated and accelerated very precisely for optimum distortion control.

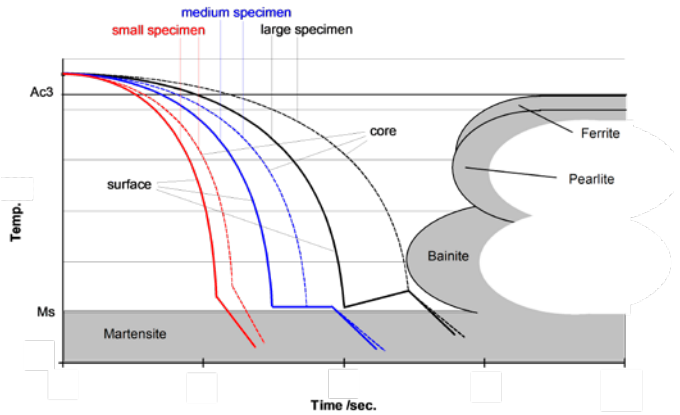


Figure 4—Schematic illustration of Dynamic Quenching for specimen of different sizes.

The application of Dynamic Quenching leads to a reduction of thermal stresses during quenching and thus it offers the potential to reduce heat treatment distortion for certain applications. In addition, a positive effect on fatigue properties can be achieved as well by applying this process modification.

Reversing Gas Flow

High-pressure gas quenching is typically performed with a flow direction from top to bottom through the load. However modern gas-quenching chambers offer the possibility to reverse the direction of the gas flow during quenching. Reversing gas flow means that the flow of gas is alternated back and forth from top-to-bottom and bottom-to-top. By alternating the gas flow direction, there is less difference in the cooling curves of parts placed in different layers. This reduces the variation of distortion inside the load.

A schematic view of a quench chamber with reversing gas flow is shown in Figure 5. To allow for the alternating flow direction, the chamber is equipped with flaps that are operated pneumatically. Depending on the setting of the valves, either top-to-bottom or bottom-to-top flow direction is put into effect. The alternation of the flow direction is time controlled.

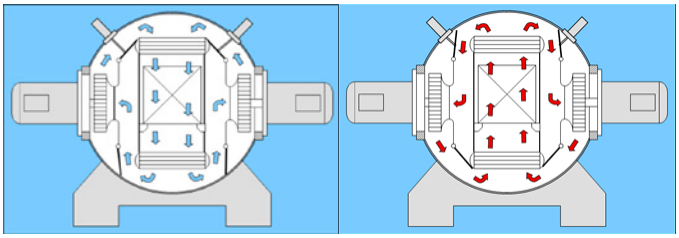


Figure 5—Reversing Gas flow.

Distortion Studies

Comparison of LPC and HPGQ Versus Atmospheric Carburizing and Oil Quench

Sliding gears made of 8620 material used to be carburized in atmosphere and quenched in oil. For this application, the hardenability of 8620 material was too low to allow for gas-quenching. Therefore, the steel grade was changed to 4320H material.

The gears have an outer diameter of 92 mm, an inner diameter of 30 mm, and a height of 24 mm. The specification after heat treatment calls for surface hardness of 58–64 HRC, core hardness of 35.1–43.3 HRC, and case hardening depth CHD at the pitch of 0.75 mm–1.3 mm. The microstructure in the case-hardened layer must consist of a minimum of 90 percent martensite, not more than 10 percent retained austenite, and no bainite.

For a distortion study, one load with gears made of 8620 material was carburized in atmosphere and oil quenched and one load made of 4320H material was low pressure carburized and gas quenched. A picture of the LPC load can be found in Figure 6.

Figure 6—Load of sliding gears (CFC-fixture consisting of 12 layers).

Twenty parts were measured in each load. Figure 7 and Figure 8 show the absolute geometrical values after heat treatment, not the change during heat treatment.

Four teeth are measured per gear. "Helix average" is the average helix value from those 4 teeth of one gear. Figure 7 shows the average values from 20 measured parts of Helix average as well as the maximum and minimum value from those 20 parts for both processes. The spread of "Helix average" is clearly reduced with the LPC and HPGQ—process.

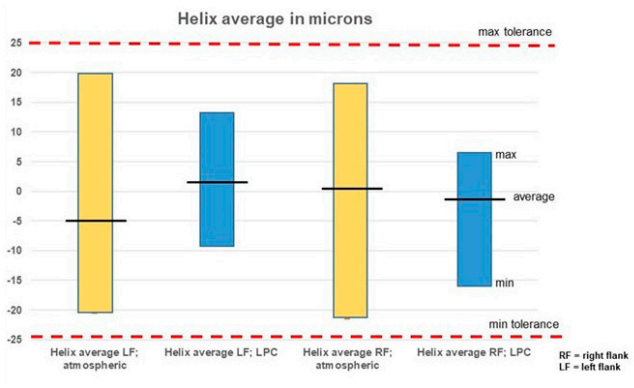


Figure 7—Helix average of sliding gears; comparison of atmospheric carburizing and oil quenching versus LPC and gas quenching.

"Helix variation" is the difference of maximum and minimum helix value from the 4 measured teeth per each gear. Figure 8 shows the average values of "helix variation" from 20 measured parts as well as the maximum and minimum values of "helix variation" from those 20 parts.

The "helix variation" is strongly reduced when applying LPC and HPGQ, see Figure 8. For the left flank, the average "helix variation" is reduced by 59 percent, and for the right flank by 48 percent. When applying LPC and gas quenching, the "helix variation" is safely within the maximum tolerance of 50 microns. This offers significant potential for cost savings in hard machining.

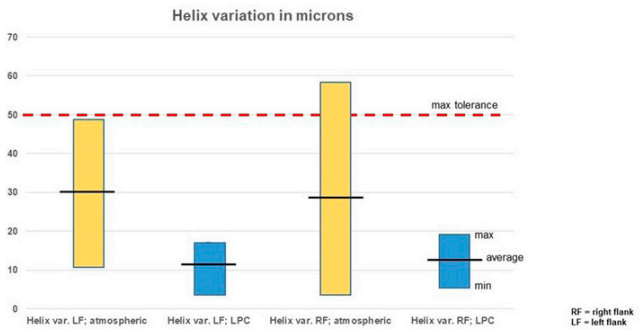


Figure 8—Helix variation of sliding gears; comparison of Atmospheric carburizing and Oil quenching versus LPC and Gas quenching.

Size-Change of Pinion Gears When Applying LPC and HPGQ

The size change of pinion gears was monitored during serial production when applying LPC and HPGQ. The pinion gears are made of SAE 5120H material with an outer diameter of 34 mm, an inner diameter of 20 mm, a height of 15 mm, and a weight of 0.055 kg per part, see Figure 9. The case hardening depth CHD after heat treatment is specified as being from 0.5–0.8 mm.

Figure 9—Load for heat treatment of pinion gears made of SAE 5120H material.

Three parts each from 140 production loads were measured. Figure 10 shows the size change of the inner diameter. The inner diameter is shrinking by an average of 39 microns. The shrinking is stable and predictable within a load and from load to load.

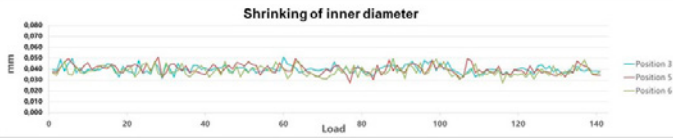


Figure 10—Size change of inner diameter of pinion gears after LPC and HPGQ; 3 parts measured each from 140 production loads.

Size-Change of Inner Splines of Gear Shafts When Applying LPC and HPGQ

Gear shafts made of 20CrMnTi material were analyzed regarding shrinking of the inner diameter at the spline. Figure 11 shows the measurement positions.

The shafts have an outer diameter of 48 mm, a height of 233 mm, and a weight of ca. 2.7 kg. The specification after heat treatment calls for a case hardening depth CHD = 0.6–0.9 mm and a surface hardness = 59–63 HRC.

Twenty shafts were analyzed regarding the size change of the inner diameter after applying the process of LPC and gas quenching.

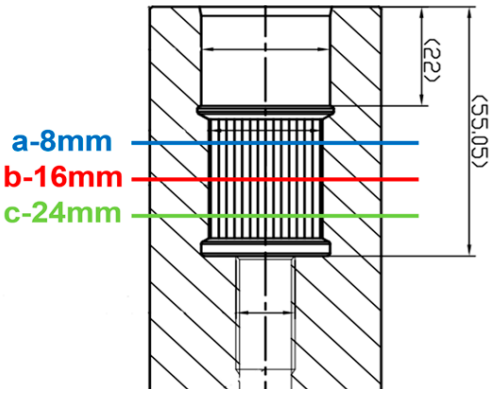


Figure 11—Measurement positions for the inner spline of a gear shaft.

Figure 12 shows the average shrinking and the variation of shrinking at the positions a, b, and c of the inner spline. A homogenous shrinking on the three measurement positions is demonstrated.

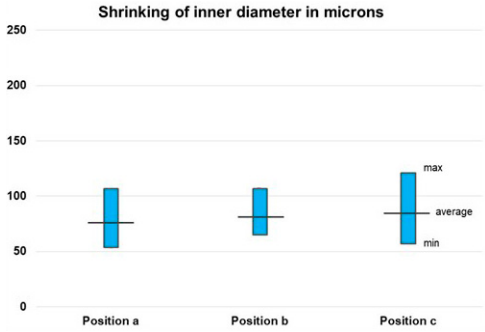


Figure 12—Shrinking of the inner spline of a gear shaft on different positions after LPC and HPGQ.

Optimized Fixturing

Final drive ring gears made of 4121 mod material (see Figure 13) were treated with different designs of fixtures to improve distortion control. The parts have an outer diameter of 226 mm with 59 external teeth, a height of 32 mm, and a weight of ca. 4.2 kg.

The case hardening depth CHD is specified as 0.7–1.1 mm, the surface hardness as 64–69 HR45N, and the core hardness is specified to be above 28 HRC.

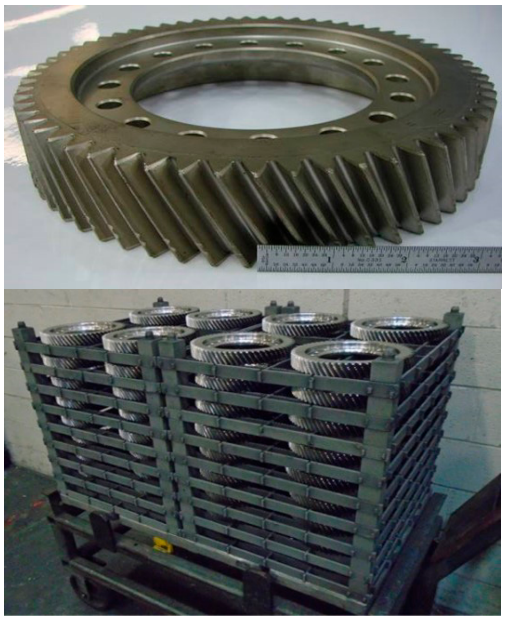


Figure 13—Final drive ring gear and production load consisting of 9 layers.

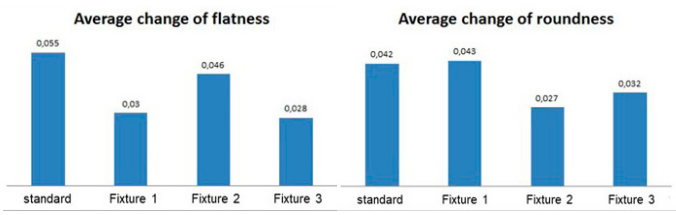


Figure 14—Change of flatness and change of roundness of final drive ring gears using different fixtures applying LPC and HPGQ.

Figure 13 shows the standard fixture which is used in serial production. Three new designs of fixturing were tested to improve distortion control.

Average change of flatness and average change of roundness are given in Figure 14. With "Fixture 3" the distortion control was clearly improved:

- Change of flatness was reduced by 49 percent.
- Change of roundness was reduced by 24 percent compared to standard fixturing.

As the new design could not be validated in a PPAP (Production part approval process), it was not yet possible to implement this improvement into serial production. However, it was demonstrated that fixture design has clear potential to improve future distortion control.

Reversing Gas Flow

The following gives an application example of the reversing gas flow process described in the "Reversing Gas Flow" section. The treated gears are made of 5120 materials, have an outer diameter of 31 mm, a height of 32 mm, and have 24 external teeth, see Figure 15. One load consists of 1.056 pieces treated in 9 layers.

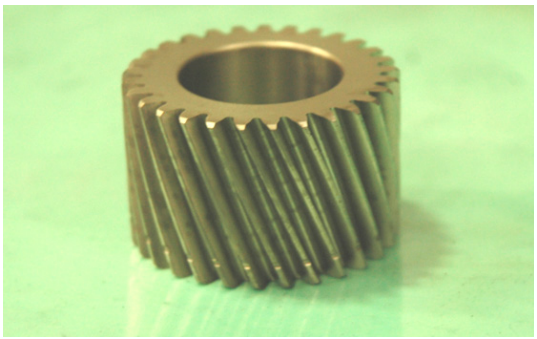


Figure 15—Final-drive pinion planetary gear (diameter = 31 mm, 24 teeth).

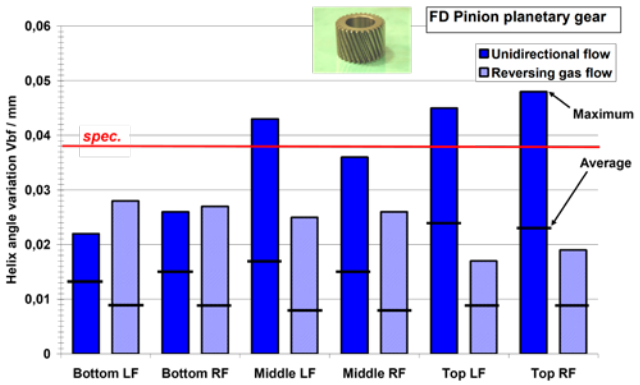


Figure 16—Reduction of distortion by application of reversing gas flow: comparison between unidirectional and reversing gas flow (helix angle variation of final-drive pinion gears after heat treatment in bottom, middle, and top layer of the load; LF = left flank; RF = right flank).

Figure 16 shows the improvement achieved when introducing the reversing gas-flow process. When applying unidirectional gas flow, the gas flows only from top-to-bottom through the load. With reversing gas flow, the flow alternates back and forth from top-to-bottom and bottom-to-top, as illustrated in Figure 5. As shown in Figure 16, with unidirectional flow, the parts in the middle and top layers of the load exhibit excessive distortion. With reversing gas flow, the helix angle variations were significantly reduced. For example, for the right flank of the gears from the top layer of the load, the maximum helix angle variation was reduced by 61 percent.

With the optimized reversing gas-flow process it is not necessary to machine the teeth of these final-drive pinion gears after heat treatment. Only the bores and faces of the gear are machined after heat treatment. This example shows the significant potential to reduce distortion by reversing gas flow.

Optimized HPGQ—Process Parameters

The distortion control of drive gears made of 20CrMnTi material was improved by optimizing the HPGQ- parameters. The gears have an outer diameter of 127 mm with 79 external teeth, a height of 12 mm, and a weight of ca. 0.3 kg, see Figure 17.

The specification after heat treatment calls for CHD = 0.5–0.8 mm, surface hardness = 58–62 HRC, and core hardness needs to be above 30 HRC.

Figure 17—Drive gear.

Figure 18 shows roundness values after LPC and HPGQ. Three sets of quench parameters were tested and 100 pcs were measured in each test.

With "Quench 1" the gas flow direction was from top to bottom. With "Quench 2" the gas flow direction was changed, so that the gas is flowing from bottom to the top. This resulted in a significant reduction of roundness values. With "Quench 3" the quench intensity was slightly reduced compared to "Quench 2", which however did not result in further improvements.

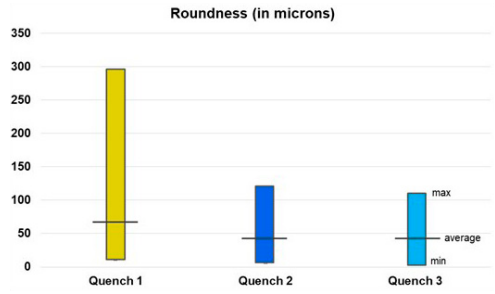


Figure 18—Roundness of drive gears with different HPGQ—parameters.

Summary

The LPC (Low-Pressure Carburizing) and HPGQ (High-Pressure Gas Quenching) process offers significant potential for advanced distortion control. The gas quenching process provides a more homogenous heat transfer coefficient on the surface of the quenched components when compared to quenching with liquids such as oil or polymers. In addition, the HPGQ process provides the flexibility to tailor the quench intensity specifically for the needs of the quenched components. The quench intensity can be tailored by defining the quench pressure (from 2 bar to 20 bar) and the gas velocity (from 2 m/s to 20 m/s).

For slide gears, it was demonstrated that distortion control was strongly improved when changing from Atmospheric carburizing and Oil Quenching to LPC and HPGQ. For the left flank, the average "Helix variation" was reduced by 59 percent, and for the right flank by 48 percent. In this application, the steel grade was changed from 8620 material to 4320H material to allow for HPGQ. This change results in higher costs for the material. However, the higher costs of material are overcompensated by the cost-savings in the field of hard machining resulting from the improved distortion control.

The size-change of pinion gears was monitored during serial production when applying LPC and HPGQ demonstrating stable shrinking of the inner diameter within a load and from load to load. On gear shafts, it was demonstrated that a homogenous size change (shrinking) of the inner splines was achieved with LPC and HPGQ.

A distortion study on final drive ring gears showed the importance of fixture design. The change of flatness was reduced by 49 percent and change of roundness was reduced by 24 percent when improving fixture design.

The HPGQ process offers further options such as "dynamic quenching" (variation of the quench intensity during the quench) or "reversing gas flow" (alternating gas flow direction during the quench) to improve distortion control.

The process modification "reversing gas flow" was applied on the final drive pinion planetary gears. With reversing gas flow, the flow alternates back and forth from top-to-bottom and bottom-to-top. By doing so, the helix angle variations were significantly reduced. For example, for the right flank of the gears from the top layer of the load, the maximum helix angle variation was reduced by 61 percent.

PTE

Dr. Ing. Volker Heuer studied metallurgy and material science at RWTH Aachen University in Germany. Starting in 1999, he worked as a research engineer at ALD-Vacuum Technologies; from 2007 to 2020, he was the Director of R&D; since 2020, he has been the CTO of the Heat Treat Service Division.

Jochen Friedel studied materials technology at the University of Applied Science Giessen-Friedberg (Germany), where he graduated as Diplom-Ingenieur. Today he is the director of process engineering in North America and China for the heat treat service division (HTS) of ALD Vacuum Technologies GmbH.

David Bolton has 30 years of experience at Allison Transmission / GM Powertrain as an advanced manufacturing engineer for transmission gears and shafts, 14 years of experience at ALD thermal treatment as a senior manufacturing engineer for heat treat distortion control and is currently an independent consultant.

Orlando García started his career in the vacuum heat treatment industry in 2013 as a metallurgical R&D Engineer at ALD-TT in Ramos Arizpe, Mexico. Currently he is the metallurgy manager at ALD-TT Ramos Arizpe and he is responsible for the process technology and all R&D-projects of the plant.

References

1. Heeß K. et al, 2022, Size-change and form-change during heat treatment of steels (Maß- und Formänderungen infolge Wärmebehandlung von Stählen); edition #6, expert-Verlag Germany, ISBN 978-3-8169-3531-5.
2. Heuer V, 2013, Chapter "Gas Quenching"; Volume 4A, ASM handbook Steel Heat treatmenting Fundamentals and Processes, ISBN 978-1-62708-011-8: 2013; pp. 222–231.
3. Loeser, K.; Heuer, V.; Schmitt, G.: Selection of quench parameters for the High Pressure Gas Quenching of components made of varrious steel-grades (Auswahl geeigneter Abschreckparameter für die Gasabschreckung von Bauteilen aus verschiedenen Einsatzstählen), 2005, HTM Haerterei-Techn. Mitt. HTM # 60 (2005) 4, pp. 248–254.
4. Heuer, V., Loeser, K. Schmitt, G.: Improved Materials and Enhanced Fatigue Resistance for Gear Components; AGMA Technical Paper 15FTM02, 2015. ISBN 978-1-55589-008-7.
5. Stich, A., Tensi, H.M.: 1995, Heat tranfer and temperature distribution during liquid quenching, (Wärmeübertragung und Temperaturverteilung mit Benetzungsablauf beim Tauchkühlen), HTM Haerterei-Techn. Mitt. # 50 (1995) 1, pp. 31-35.
6. Heuer, V.; Loeser, K.; Faron, D.R.; Bolton, D.: Low distortion heat treatment of transmission components; AGMA Technical Paper 10FTM04, 2010. ISBN 978-1-55589-979-0.
7. Altena H., Schrank, F. und Jasienski, W., 2005, Reduction of form-change on gear components in pusher-furnaces applying High Pressure Gas-Quenching (Reduzierung der Formänderung von Getriebeteilen in Gasaufkohlungs-Durchstoßanlagen durch Hochdruck-Gasabschreckung), HTM Haerterei-Techn. Mitt. # 60 (2005) 1, pp. 43–50.
8. Heuer, V., Bolton, D., Friedel, J, 2021, Enhanced distortion control – ISO class 8 gears after case hardening, AGMA Technical Paper 21FTM18, ISBN 978-1-64353-112-0.
9. Heuer, V., Löser, K.: Entwicklung des dynamischen Abschreckens in Hochdruck-Gasabschreckanlagen. In: Mat.-wiss. u. Werkstofftech. 34 (2003), pp. 56–63.

TIMKEN
Announces CEO Succession Plan

Tarak Mehta

The Timken Company board of directors has reached an agreement with Tarak Mehta to become Timken's next president and chief executive officer Sept. 5, 2024. Mehta is currently president of the Motion business and member of the Group Executive Committee at ABB Ltd., a $32 billion leader in electrification and automation. Mehta will be appointed Timken president and CEO after he completes a transition period with ABB.

Richard G. Kyle

Richard G. Kyle will remain president and CEO until Mehta's appointment date. At that time, Kyle will move into an advisory role to assist with the leadership transition. Kyle plans to retire as an employee of Timken following a decade of leadership as CEO but will continue to serve on the Timken board of directors.

Mehta has 35 years of industry experience, including a 26-year career at ABB. As president of ABB's Motion business, he has extensive experience accelerating organic growth and innovation across global industrial markets, scaling business portfolios through M&A transactions and helping customers save energy and improve efficiency. While at ABB, Mehta held a variety of global business leadership positions of increasing responsibility, including president of Electrification Products. Mehta will be joining the Timken team in North Canton, Ohio, and is expected to be appointed to the Timken Board of Directors at a future date.

"Bringing on a seasoned industry executive like Tarak as CEO underscores the Board's commitment to advancing Timken's industrial diversification strategy. Tarak is an accomplished and highly respected global executive. He is exceptionally qualified to lead Timken through our next chapter of growth and has a proven track record of developing global teams and operational excellence. Tarak's customer-centric innovation and market-leading growth strategies will further Timken's leadership across the globe," said Timken Chairman, John M. Timken, Jr.

Kyle joined Timken in 2006 and was appointed president and CEO in 2014. He is credited for transforming the company into a global diversified industrial leader while achieving record-levels of financial performance. As CEO, he established two industry-leading business segments, Engineered Bearings and Industrial Motion, and significantly evolved the company's market mix. Kyle's disciplined capital allocation, operational rigor and focus on profitable growth enabled Timken to build scale, enter new product lines, expand globally and diversify its end markets to drive shareholder value.

"On behalf of the board of directors, I would like to thank Rich for his outstanding achievements, his personal integrity and for the significant impact he has had on the company," said John Timken. "Timken stands stronger today than at any time in our 125-year history, reflecting Rich's leadership and stewardship as CEO. During his tenure, Rich developed a talented leadership team and positioned the company for future success. We are pleased that Rich will continue as a member of the Board following his retirement as president and CEO."

timken.com

MOTION
Appoints James F. Howe President

James F. Howe

Genuine Parts Company, a global distributor of automotive and industrial replacement parts, has announced that its board of directors has appointed James F. Howe to the position of president, Motion, the company's industrial business, effective April 1, 2024. With nearly three decades of dedicated service to the company,

Howe brings a wealth of experience and expertise to his new role.

Most recently, Howe served as the executive vice president and chief commercial and technology officer, where he played a pivotal role in shaping the corporate trajectory of Motion. His leadership in overseeing eCommerce, strategic pricing, sales excellence, corporate accounts, and human resources has been instrumental in driving the company's success.

In his new capacity, Howe will continue to report to Randy Breaux, group president, GPC North America.

"James has an impressive history, having served in numerous executive roles during his long career at Motion," said Paul Donahue, Chairman and CEO. "His extensive experience makes him an excellent choice to lead Motion. We feel confident that under James's leadership, our talented and experienced Motion team will continue to achieve great results."

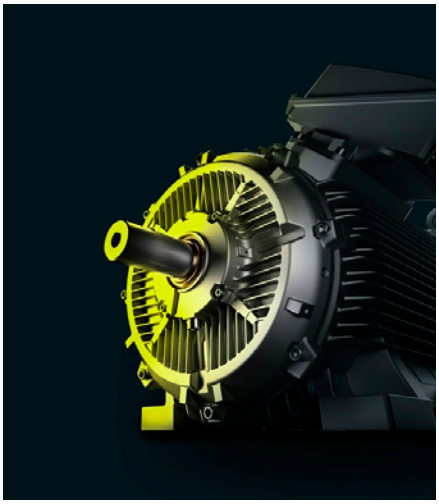
motion.com

INNOMOTICS AND UNIVERSITY OF PITTSBURGH

Announce Winner of Prestigious Engineering Scholarship

Innomotics and the University of Pittsburgh's Swanson School of Engineering are thrilled to announce Josh Samuel Lubin as the recipient of the 2024 Peter Hammond Scholarship. A master's student in engineering at the University of Pittsburgh Department of Electrical and Computer Engineering, Lubin has been selected to receive the scholarship for $10,000. Now in its fifth year, this award is presented to outstanding graduate students pursuing studies in electrical engineering, exemplifying both academic excellence and innovative research.

"I am very proud to receive this scholarship," Lubin said. "It will further drive my current research and inspire me to produce results that can push the field of electrical engineering in a positive direction."



Lubin, an exemplary student with a Bachelor of Science in Electrical Engineering from the University of Pittsburgh, has demonstrated remarkable dedication and innovation in his field. With impressive academic marks and consistent Dean's List honors throughout his undergraduate education, Lubin's academic achievements are commendable. His involvement in groundbreaking research regarding permanent magnet motors without the use of rare earth metals showcases his commitment to advancing sustainable engineering solutions. This research, significant for its potential impact on the electric vehicle market, illustrates Lubin's forward-thinking approach and his potential to contribute significantly to the engineering community.

"We are incredibly excited about this scholarship and the opportunity it will provide for a graduate student studying electric power engineering at the Swanson School of Engineering," said Kevin Wissner, Director of Research & Development at Innomotics based in New Kensington, PA. "Our dedication to fostering local talent and future engineering pioneers is at the heart of this scholarship fund. The initiative is one of many ways we strive to contribute to the development of the engineering field and support the cultivation of young, innovative minds."

Lubin's work, particularly his thesis on the effects of faults on the demagnetization in motors, is poised to offer valuable insights into the reliability and efficiency of permanent magnet motors. Additionally, this research and Lubin's passion for the topic aligns perfectly with Innomotics' commitment to fostering innovation and supporting the next generation of engineers in overcoming challenges in the field of electrical engineering.

In addition to his rigorous academic pursuits, Lubin has engaged in practical engineering experiences, from co-op positions to leadership roles in engineering clubs and competitions, further demonstrating his hands-on approach and leadership skills in the engineering domain.

"What Josh is doing now is reflective of what Innomotics is looking for in future engineers as part of their business units," says Brandon Grainger, associate director of the Energy GRID Institute, Eaton Faculty Fellow, and associate professor of electrical and computer engineering at the Swanson School. "His research in permanent magnet-based motor drives is making an impact in the electric power industry space including renewable energy and electric vehicle markets. A university who develops strong company collaborations like this will find it instrumental in implementing novel ideas to benefit people in society and helps bring confidence that projects will be almost 100 percent successful. Technology-to-market strategies are critical for any investment being made in new technology directions."

As the University of Pittsburgh and Innomotics continue their partnership to empower future engineers, Lubin's achievements and potential underscore the significance of this scholarship in cultivating the talents of those who will drive innovation and advancement in the engineering field. Innomotics continues to work closely with the local community and institutions to bolster the growth and advancement of future engineers by alleviating financial barriers. Recognizing the increasing demand for engineers in the modern world, this concrete step is designed to invest in this the future workforce. The scholarship intends to not only support

the academic pursuits of promising engineering students but also encourages innovative thinking and problem-solving skills among the beneficiaries.

innomotics.com

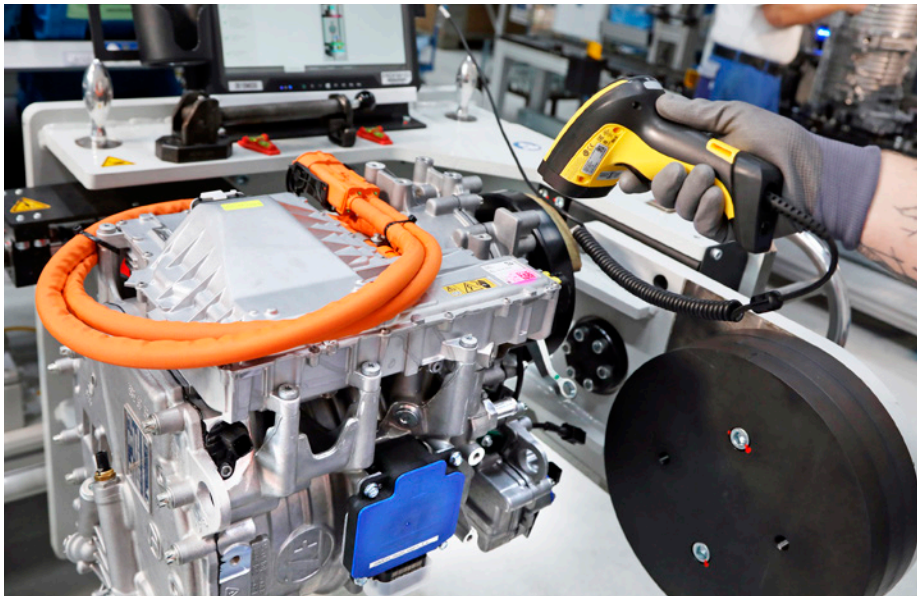
ZF

Produces 1,000 Electric Commercial Vehicle Drives

After volume production of the CeTrax lite electric drive for light commercial vehicles started in April 2023, ZF has already produced its first thousand units. The ramp-up in volume production was steeper than planned because demand from the customer ISUZU increased. The drive is used by ISUZU to power the latest generation its light distributor truck, the ISUZU ELF EV. Further volume production is set to start imminently this year. The electric central drive for light commercial vehicles continues the success story of its "big brother" CeTrax, which went into volume production in 2020. The central drive, which is also produced at the ZF Friedrichshafen location, is mainly used in buses with orders from customers in South Korea, the USA, Australia, and Europe. With its high level of reliability, the robust central drive "made in Friedrichshafen" has made a name for itself worldwide in the tough everyday life of public transport. In addition, the new CeTrax 2 dual electric central drive will be manufactured from Friedrichshafen from now on.

A special feature of ZF's CeTrax concept is that the all-electric central drive is suitable for electrifying existing commercial vehicle platforms. In this way, manufacturers can expand their portfolio towards purely electric vehicles without having to make further significant alterations to their design platforms.

As the volume production of the "large" CeTrax, which has also been manufactured in Friedrichshafen since 2020, shows, this concept is particularly attractive for manufacturers of city buses, as well as for special vehicles operating in ports and logistics centers. Electrification with



CeTrax lite offers just as much potential for small delivery trucks, city buses or special vehicles, which are mainly used for the "last mile" deliveries to consumers and therefore are perfectly suited to operate in low-emission zones of inner-city environments.

From Friedrichshafen to the World

CeTrax lite is an all-electric drive with a peak output of 150 kW that sits centrally in the vehicle frame – the space normally occupied by the conventional transmission in "combustion vehicles." The key customer is the Japanese commercial vehicle manufacturer ISUZU, which has been supplying its ELF EV vehicles equipped with CeTrax to customers worldwide since October 2023.

As demand at ISUZU increased, production figures at Friedrichshafen are also on the rise. "We are proud to have met the needs and requirements of the market with our CeTrax lite. CeTrax lite is on its way to becoming a successful global product and is accelerating purely electric and locally emission-free delivery traffic," says Kleber Vinhas, location manager of the ZF Friedrichshafen plant. "At the same time, we are investing and preparing further volume production launches for customers with the CeTrax 2 dual, the next electric central drive from Friedrichshafen for heavy commercial vehicles, set to start production."

High Level of Added Value

ZF is able to generate a high level of production and added value for the CeTrax lite because many of its components will also be manufactured by ZF at other locations for final assembly in Friedrichshafen, including Schweinfurt and Auerbach. "An electric drive from ZF means that the hardware components and the software are optimally matched," adds Kleber Vinhas. "This makes CeTrax lite particularly efficient in practice."

zf.com

PRECISION DRIVE SYSTEMS

Add Kelly Johnson as Design Engineer

Precision Drive Systems (PDS), a global provider of precision motor spindles, expert support, and repair services near Charlotte, NC, has announced that they have hired Kelly Johnson as a Design Engineer for new engineered products and services.

"Kelly's experience as a mechanical and manufacturing engineer combines technical proficiency and practical experience to bridge the gap between design and production to optimize operational productivity and product quality," said Robert Turk, President of PDS. "Her proven ability to analyze complex

mechanical and technical problems will help the PDS team significantly increase efficiency, reduce downtime, improve product durability, and streamline production processes to support our client's production and business goals." At PDS, Kelly will support the PDS sales team and its clients by engineering new spindle designs, accessory designs, and drawings of complex precision mechanical components, complete with Geometric Dimensioning and Tolerancing specifications.

Before joining PDS, Kelly was a manufacturing engineer at DCI Edge, a design engineer at Cabteq, a design drafter at Pelton & Crane Company, and a CAD designer at Alemite, LLC. Kelly studied Mechanical and manufacturing engineering technology at Central Piedmont Community College in Charlotte, NC.

spindlerepair.com

FORTIFI

Appoints Victor Nieto as EVP of Lean Transformation & Growth

Fortifi Food Processing Solutions ("Fortifi") has appointed Victor Nieto as executive vice president of lean transformation and growth effective May 1, 2024. Fortifi's unified platform of leading global brands and products transforms food processing and automation solutions.

Reporting directly to Massimo Bizzi, chief executive officer of Fortifi, Nieto will lead lean implementation and continuous improvement. He also will guide the development of the Fortifi business operating system, which will make Fortifi the premier aggregator in an otherwise fragmented industry. His guidance will standardize Fortifi's operational roadmap, quality management and KPI development.

"The breadth of Victor's expertise in logistics, operations, procurement, acquisitions, and Lean and Continuous Improvement initiatives makes him a focal asset on our team," said CEO Massimo Bizzi. "With his exceptional track record of success in maximizing product and customer-experience quality, he brings a big-picture viewpoint that matches Fortifi's emphasis on sustained global success."

Nieto most recently spent three years in executive positions of increasing responsibility for supply chain, product quality and operations at Switzerland-based Sonova Holding AG, a manufacturer of hearing instruments. He previously served for more than six years as a global supply chain executive at leading life sciences and diagnostics innovator Danaher Corporation, including the Envista Holdings Corporation spun off from Danaher. He began his career with 22 years in 10 roles at food giant Kellogg Company's international operations in Ireland, the U.S. and Mexico.

"Fortifi is uniquely positioned to revolutionize food technology and redefine efficiency in food processing," Nieto said. "I look forward to contributing my experience and insights to Fortifi's expanding global operations."

Nieto earned a BS degree in Biochemistry and Food Processing from Tecnológico de Monterrey and holds certifications in quality system regulation and Kaizen problem solving. He is based at Fortifi's global headquarters in The Woodlands, Texas.

FortifiFoodSolutions.com

VOITH TURBO

Completes $5.8 Million Expansion to its York County Workshop

On May 7, 2024, Voith Turbo celebrated the completion of its almost $6 million workshop expansion in York County, PA., a move that's been driven by increased rail business where Buy America compliance is a critical component. The project added 10,000 square-feet to the workshop facility. A ribbon cutting for the expansion took place at the workshop, which is also the location of Voith Turbo's North American headquarters, and included local and state officials, as well as employees.

"Such growth not only reflects our dedication to meeting the evolving needs of our customers, but also underscores our unwavering commitment to American manufacturing," said Ralf Dreckmann, president of Voith Turbo in North America.

According to Buy America compliance guidelines, a significant portion of a federally assisted projects, must be manufactured in the United States. Voith's workshop expansion in York, PA. allows for Voith Turbo to expand their capacity to meet Buy American compliance requirements especially for rail products.

"This expansion is a strategic choice to invest in the United States—and specifically, into York, Pennsylvania," said Cornelius Weitzmann, president and CEO of Voith Turbo. "We know that we can rely on the local capabilities of our team here to best serve our rail customers in the growing U.S. market. With this investment, Voith Turbo is in a fantastic position in the United States, and we want to set our sights on achieving even more significant growth together with our customers over the next few years."

Voith Turbo's York, PA. location has been in operation since 1990, and this is its fourth expansion at the site since then. The location has more than 140 employees assigned to it, and the work just completed allows for a 15 percent increase in workforce.

With the additional workshop space, Voith Turbo's Pennsylvania location will transition from mostly service-based disassembly and reassembly operations to a location that also provides new business manufacturing. As a result, Voith's rail customers will benefit from the expanded capabilities of the location while also supporting Voith's higher volume products, namely gearboxes and couplers.

voith.com

June 12–13

Dritev 2024

The world of powertrain is currently navigating the tensions between increasing CO2 emissions in vehicle fleets, an explosive increase in drivetrain variants, cost pressure and regulatory interventions by governments. Many questions are still open and issues unresolved. That's why companies are pursuing a variety of drivetrain strategies that will lead to a comprehensive electrification of the drivetrain, as this is the best way to be prepared for the future. The International VDI Congress "Dritev" is one of the world's largest automobile congresses—be part of the community in Baden-Baden! Hundreds experts with an R&D background meet every year to exchange thoughts on current developments in the field of drivetrain and transmission. It's the ideal place to reach out to long-known fellow experts, find new project partners and pave the way to establish new business ties.

powertransmission.com/events/953-dritev-2024

June 16–19

PowderMet 2024

The leading technical conference on powder metallurgy and particulate materials in the Americas, PowderMet 2024 (Pittsburgh, PA) is a hub for technology transfer for professionals from every part of the industry, including buyers and specifiers of metal powders, tooling and compacting presses, sintering furnaces, furnace belts, powder handling and blending equipment, quality-control and automation equipment, particle-size and powder-characterization equipment, consulting and research services, and much, much more. The show is co-located with AMPM 2024 focusing on metal additive manufacturing. AMPM 2024 will feature worldwide industry experts presenting the latest technology developments in this fast-growing field.

powertransmission.com/events/954-powdermet-2024

June 25–26

Bearing World by FVA

Bearing World, presented by FVA, focuses on the topic of bearings in theory and application. In technology, wherever there is movement, rolling elements and plain bearings are essential. This is true for general mechanical engineering, the automotive industry, and others. Bearings transmit operating forces between moving machine components, and therefore play a crucial role in the functionality, efficiency, and service life of the overall machine or system. The stresses on rolling bearings are very high, and will continue to increase in the future, as will expectations of reliability. The event takes place in Wurzburg, Germany.

powertransmission.com/events/870-bearing-world-by-fv

June 25–27

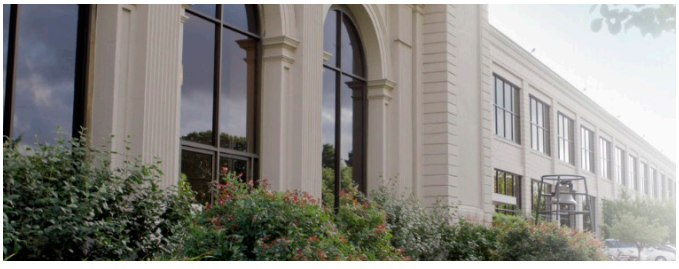
RAPID + TCT 2024

For more than 30 years, RAPID + TCT has defined the crucial role of additive manufacturing and industrial 3D printing by empowering the establishment of an industry that continues to conceive, test, improve and manufacture new products at a faster, more cost-efficient pace. RAPID + TCT provides everything you need to know about the latest 3D technologies, all under one roof. At the RAPID + TCT conference, over 100 industry leaders go beyond the hype to bring you real-world solutions to advance your manufacturing processes. New this year are the Hollywood Showcase, an exploration of the role of AM in movie magic, and The Discovery Zone, a launchpad for newcoming exhibitors with groundbreaking ideas.

powertransmission.com/events/982-rapid-tct-2024

July 16–18

WZL Gear Conference USA



The 10th WZL Gear Conference - USA is being hosted by Gleason Corporation in Rochester NY and will provide the opportunity for North American companies to connect with WZL and learn about current research activities. For more than 50 years the annual WZL Gear Conference in Aachen, Germany, has been fostering technical collaboration and communication among the members of the WZL Gear Research Circle. The two-day conference is devoted exclusively to the presentation of the latest research in gear design, manufacturing and testing. Additionally, the software resources of the WZL Gear Research Circle are available for examination, including solutions for ger design and manufacturing process development. Participants of the conference are encouraged to tour the WZL laboratory with its shop floor and test rigs. Within this environment associations are formed and the exchange of knowledge among the members of the technical community is promoted. With up to 300 participants from Europe and overseas, the WZL Gear Conference is one of the largest annual events dedicated to gear technology in Europe.

powertransmission.com/events/983-wzl-gear-conference-usa

AD INDEX

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Mechanical Motion in Space

Matthew Jaster, Senior Editor

Spacecraft commonly contain onboard devices whose function are based on mechanical movement (i.e.: slide, roll, rotate, separate, unfold, or spin) to either modify part of the spacecraft's geometry or to ensure operational function of a component or instrument. These devices—according to NASA—are known as mechanisms, and as spacecraft become more sophisticated with the advances in miniaturization of electronics and systems, their reliance of mechanisms greatly increases.

The domain of spacecraft mechanisms is quite broad as there are many different types in the design and life of a spacecraft that include the moving parts associated in each phase:

Deployment: dispensing spacecraft into orbit

Beginning of mission life: deployments of solar arrays, booms, antennas, instrumentation, etc.

Mission maintenance: sun tracking, pointing antennas and instruments, active doors or shields, gyroscopes and reaction wheels, thrusters, etc.

End-of-life: deorbiting methods

The technology within the mechanism to perform the movement is accomplished with an actuator. Depending on the actuation method, spacecraft mechanisms are either passively or actively driven. Passive mechanisms do not consume electric energy and provide driving power via spring load, and active mechanisms are motorized to produce driving power for mechanism operation. Most mechanisms can use both passive and active capabilities depending on the application.

Formsprag ISS Telescope Brakes

A reliable braking solution was required for the Coronal Diagnostic Experiment (CODEX) telescope installed on the International Space Station (ISS). The solar coronagraph telescope measured electron density, velocity, and temperature of the solar wind. The 2022 mission helped increase the accuracy of sun models which are important for basic science but also space weather forecasting which is critical as the world relies heavily on satellites that are affected by solar wind.

While balloon technology has provided some measurement insights in the past, such investigations are too short in duration and limited by sky brightness to obtain all the data needed to achieve CODEX's science objectives. The remote-sensing data from the CODEX mission augmented similar remote sensing technologies. The CODEX mission enhanced the science return by combining coronal imagery in overlapping fields of view. Data returned from CODEX was deposited on the Solar Data Analysis Center website, a publicly accessible NASA repository. CODEX provided a complete investigation including payload development, instrument calibration, launch, and data analysis. The project offered well-defined technology and science breakthroughs.

The brakes were used in the telescope's Az and El axes to hold the 5 ft. long, 556 lb. unit motionless when power is turned off. This prevented damage to the telescope caused by any uncontrolled motion.

NASA engineers collaborated with Formsprag Clutch to develop a custom brake to meet the 3 ft.lb. minimum holding torque and <10 W power draw requirements of this challenging zero-gravity application.

The Formsprag custom EBR "Power Off" lightweight holding brake utilized an advanced friction disc material with a 1.30 Cf (Coefficient of Friction). The unit features a 50-millisecond reaction time and a bobbinless coil for an extended service life. The 3 in. dia. electromagnetic brake has Infinite Angular Alignment Capability (IAAC) and produces 3 ft. lbs. of torque for operation in a planetary actuator gear set. The brake is rated at only 8 watts of power and releases at around 4 watts.

Sure, brake and clutch applications for amusement park rides, mining equipment or marine vehicles make for great mechanical power transmission stories, but there's something extra special about a component working 254+ miles above Earth's surface.

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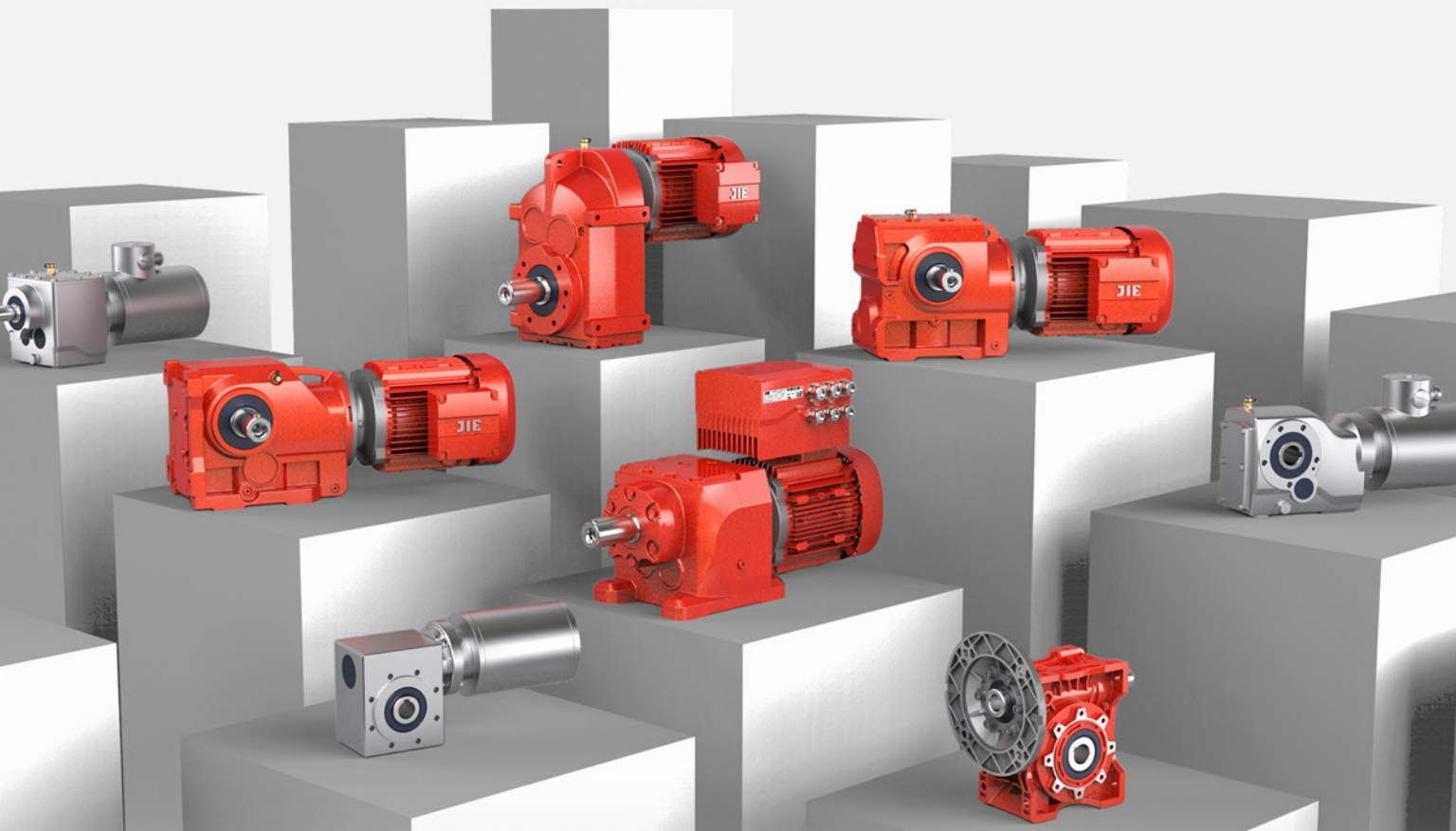

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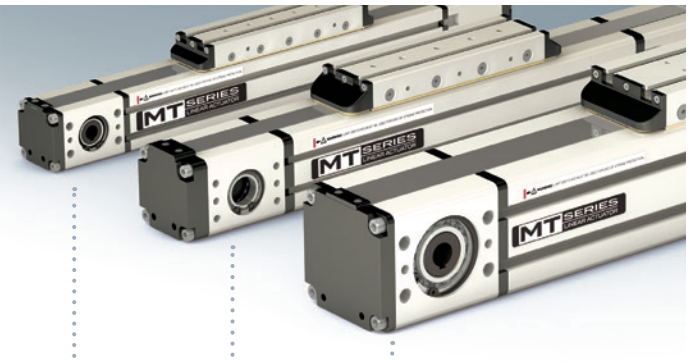
BRING ON the BRUTE FORCE LOADS

Announcing a MTB Linear Actuator Series Line Extension

The MTB Series is a belt driven, profile rail linear actuator that has a number of sizes with some design configuration availability to meet high loads and stroke length.

MTBs are fully enclosed systems that perform at speeds up to 3000 mm per/second. With the addition of the MTB 105 linear actuator, the series now can move a static load of 7500 N and with a thrust capacity of 2750 N.



MTB 42	MTB 55	MTB 80	
1560 N	1850 N	4500 N	MAX Static Load (F_z F_y)
460 N	820 N	1650 N	MAX Linear Thrust (F_x)
55 Nm	120 Nm	450 Nm	MAX Moments (M_z M_y)
2000 mm	6000 mm	6000 mm	MAX Stroke Length

MTB 105	
7500 N	MAX Static Load (F_z F_y)
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