Power Transmission Engineering®

SEPTEMBER 2017

Gear Expo is for Gear Buyers

- Booth Previews
- Map and Listings
- Showstoppers Special Section

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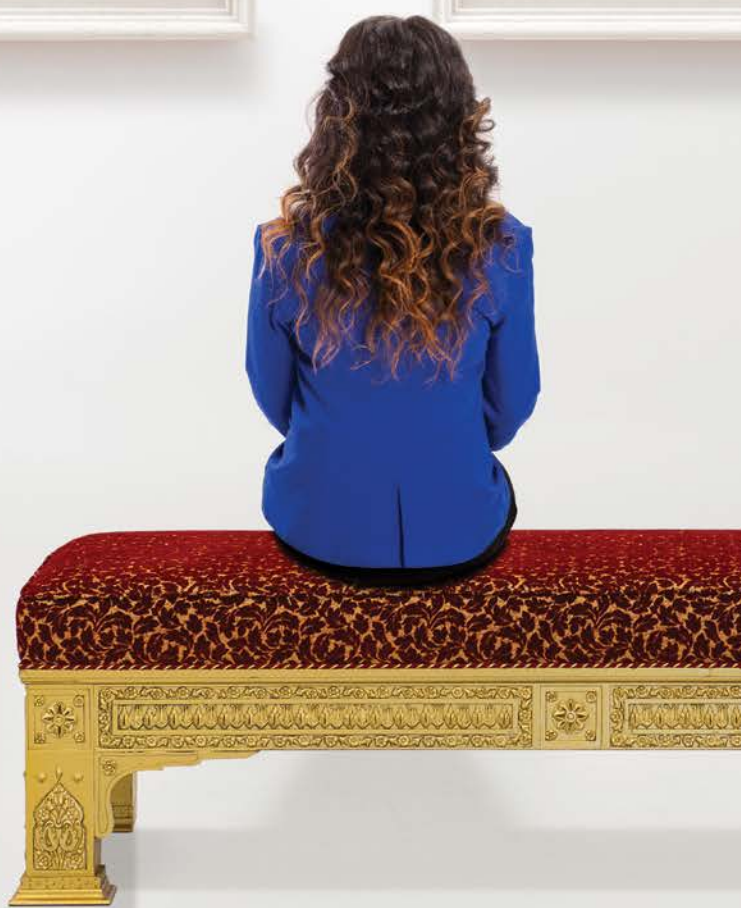

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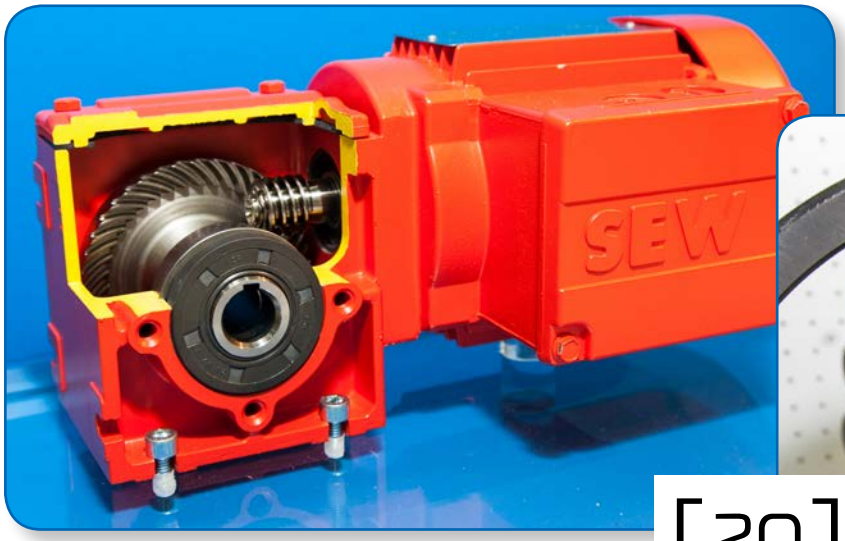

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FEATURE ARTICLES

TECHNICAL ARTICLES

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Power Transmission Engineering
VOL. 11, NO. 6

Cover photo by David Ropinski

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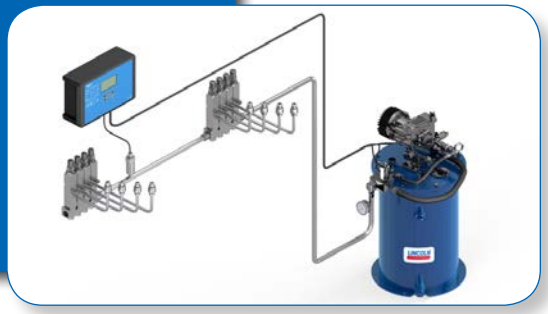
Editor's Choice

Check out our Editor's Choice Blog for the latest PT news including a look at how Iarnród Éireann Irish Rail (the national railway operator of Ireland), utilized RomaxDesignerto explore bearing issues. (*www.powertransmission.com/blog/root-cause-analysis-on-the-rails/*)

PTE Videos

Discover how SKF and Lincoln single-line lubrication systems work. This animation presents system components, working principles and typical applications.

(*www.powertransmission.com/videos/SKF-Single-Line-Lubrication-System-/*)



Event Spotlight: Gear Expo 2017

For three days, the full range of drive technology experts—design, manufacturing, application engineering, gear buyers and manufacturers—network and build relationships that benefit their respective companies. Learn more at *www.gearexpo.com*.

Ask the Expert

Do you have a question about gears, bearings, motors, clutches, couplings or other mechanical power transmission or motion control components? Submit your questions here: (*www.powertransmission.com/asktheexpert.php*)

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Randy Stott, Managing Editor

Gear Expo is for Gear Buyers

Most of you who read this magazine have a close relationship with gears and gear drives. According to our surveys, 75% of you recommend, specify or buy them. It's a shame, then, that the majority of you will miss Gear Expo (Oct. 24–26 in Columbus, OH) this year.

Don't get me wrong. I hope you'll go. I think you should. But the fact is, Gear Expo comes every two years, and most of you have been missing out on it all along. Meanwhile, the show has continued to grow in relevance to become one of the hidden gems among trade shows, particularly for those of you who rely on gears to make your products go. Particularly for those of you who are gear buyers.

Gear Expo is the only trade show in North America where you can find so many potential suppliers of gears and gear drives all in one place. There will be more than 50 gear and gear drive suppliers in Columbus this October. Whether you need open gears, gearbox repair or custom gear assemblies, you'll find qualified suppliers to choose from at Gear Expo.

You'll also find traditional gear manufacturers alongside manufacturers of plastic and powder metal gears, and you'll find them specializing in aerospace, automotive, off-highway and industrial gears. So if you're looking for some design insight or application knowledge, there's still time to book your trip.

We've talked to many of these key suppliers in advance, and we've prepared booth previews (see our article beginning on p. 20), highlighting their capabilities and product specialties. In addition, a number of our advertisers have prepared their own special messages for you in our "Gear Expo Showstoppers" advertising section (p. 28). And finally, we've customized the show map and booth listings specifically for you (p. 30), identifying the exhibits that should be of most interest to *Power Transmission Engineering* readers.

But all of this is just a taste. To get the full experience, you really have to go.

When you do, we hope you'll stop by our booth (#1022). One of the highlights this year will be our live interviews conducted by editors with many of the leading companies in the industry. Throughout the show, we'll be sitting down with product specialists and technical experts from many of these companies, and if you come to our booth, you have the chance to learn first-hand as we discuss their capabilities, unique applications and technical specialties. If you're in the audience, we'll even let you ask questions of your own.

As we did at Gear Expo 2015, we're also hosting four live sessions of our popular "Ask the Expert" column. These highly educational sessions feature some of the top experts in gearing, and they're ready to answer your questions live and in-person. If you want to sit in the audience, it's a great way to brush up on the basics, but if you feel like participating, it's also a great opportunity present your challenging design questions and learn from some of the most knowledgeable people in the industry. See our ad on page 28 for a schedule of topics and times.

There's a lot more going on at Gear Expo than I have space to describe here, including many educational opportunities both on and off the show floor and lots more exhibitors whose products and capabilities may be relevant to you. For complete information, visit the show website at *www.gearexpo.com.*

But don't just visit the show website. Visit the show October 24–26 in Columbus, OH. I hope to see you there.

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Currax

INCORPORATES SIEMENS SIMATIC S7 CONTROLLER SYSTEMS

Mechanics, electrics, automation — Currax is reinforcing its role and expanding its drive portfolio with IDS Digital. Besides a wide range of proven components and individualized engineering solutions, the Hamburg-based drive specialist is now also offering Totally Integrated Automation. CEO Daniel Assmann explains: "On our way to Industry 4.0 with cloud-based engineering, we have taken the next step and incorporated the Siemens Simatic S7 controller systems. As a result, we are able to offer our customers a bundled-up range of services on their way to the digital factory."

The Simatic S7 product line has been conceived for maximum flexibility in configuring sophisticated machines. Controller solutions can be organized individually by applying the principle of building blocks so as to meet specific requirements optimally. Since it is scalable, solutions can be customized to actual requirements extremely flexibly and economically. Moreover, maximum protection for investments is ensured thanks to strict upward compatibility.

The main focus of Currax are the Simatic Advanced Controllers. They help automatize the complete range production plants as well as applications yielding the best of performance, flexibility and interconnectivity. The advanced controllers are used in the automation of total production and applications for medium-sized and high-end machines. A variety of CPU models are available in several classes of performance in the product group of what the customer prefers.

For the controller systems, Currax will also provide in future the compatible operating and supervision systems Simatic HMI. Individual components can be perfectly integrated with the automation by consistently using open, standardized interfaces in hardware and software systems. They are suitable for panel-based as well as for PC-based single and multi-station solutions. From the simple push-button operation through mobile and stationary operating devices to the all-rounder for demanding applications, they always offer the optimal solution that is robust, compact and has versatile options of connectivity. They also offer value addition thanks to brilliant displays and secure and ergonomic operation.

"Our holistic approach is based on the vision of the Digital Enterprise," said Assmann. "In the future, we can guide our customers' production completely through Currax: products, software and cloud-applications from a single source. They will benefit from our comprehensive offer that is tailored to various industrial segments and their needs. Bearing in mind the networked production methodology of tomorrow, we would like to emphasize the clarion call "Internet of Things" for Currax. A mass of data becomes information that is evaluated and used for individual and intelligent solutions."

For more information:
Currax GmbH
Phone: +49 (40) 23648268-0
www.currax.net

GEAR EXPO 2017

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October 24–26, 2017 | **Columbus, OH**
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Yaskawa Direct Drive Servo

OPENS DOOR TO BACKLASH-FREE AUTOMATION APPLICATIONS

The Drives and Motion Division of Yaskawa America, Inc. has introduced a direct drive servomotor that packs a new level of performance into a more compact size than anything offered before.

The new Yaskawa SGM7F line of direct drive servomotors delivers from 4 to 35 Nm of torque in a device as small as 2.1" high and 5.3" in diameter (53 × 135 mm). This size advantage makes it possible to apply the mechanical benefits of a direct coupling between a servomotor and a load in tighter spaces than ever before. Machine designers can use SGM7F to make automated machinery more compact, freeing up valuable space on crowded plant floors.

The chief advantage of direct drive products is the ability to attach a load directly to the servomotor, allowing a full range of motion control without the need for a shaft coupling or gearhead. SGM7F also offers a superior level of torsional stiffness and virtually eliminates mechanical backlash. This yields an output that minimizes damage to components and maximizes positioning accuracy and repeatability.

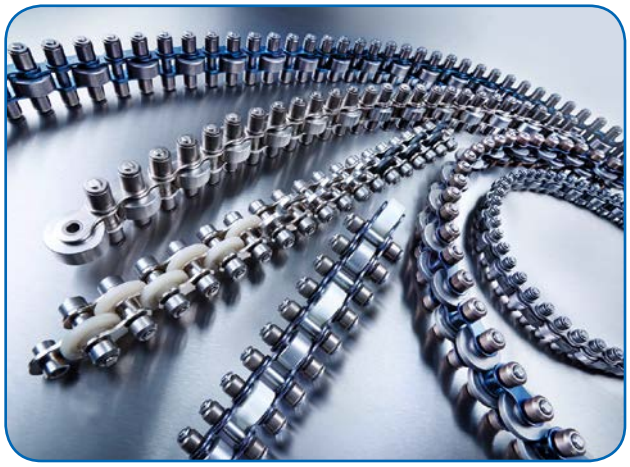
The SGM7F also offers a host of other advantages, including: an open core design that adapts easily to shaft mounting and allows wiring to pass through easily, 24-bit encoding for exceptionally precise motion control, a self-cooled design that generates a low level of heat, a design that is ideal for applications which require downsizing and shorter cycle time

The SGM7F line offers eight different models to suit a wide range of industrial applications, including dial tables, transfer lines, die actuators, electronic parts assembly, and print registration.

For more information:
Yaskawa America
Phone: (800) 927-5292
www.yaskawa.com

Iwis

OFFERS ACCUMULATION CHAIN FOR CONVEYING SYSTEMS



For logistics and material handling applications, chain specialist Iwis Drive Systems offers a comprehensive range of accumulation chains that have proven exceptionally efficient and durable — and therefore economical — in numerous comparisons. Accumulation chains are used for conveying, accumulating and separating a wide range of different goods.

As a rule, these chains run continually, driven through the track rollers on the chains' outside, which also support the chain in the profile. The conveyed goods rest on the transport or accumulation rollers, which are fitted between the chain links. Accumulation chains from iwis feature special low-friction rollers that ensure an extremely efficient operation of the chain and therefore the entire conveying system. The low-friction rollers also allow easy positioning of the transported material at any point along the transport path and remove the need to start and stop the chain, which could influence product orientation and agitate content.

The accumulation chains are available in different versions, including versions with offset accumulation rollers for optimized load distribution, maintenance-free Megalife accumulation chains with nickel-plated plates and pins for lubricant-free operation, accumulation chains with protection for fingers and small parts for increased machine and personal safety, and sidebow accumulation chains with offset accumulation rollers for conveying systems with extremely small bend radii.

For more information:
Iwis Drive Systems
Phone: (317) 821-3539
www.iwisusa.com

Parsons Peebles

EXTENDS MEDIUM AND HIGH VOLTAGE STANDARD MOTOR RANGE

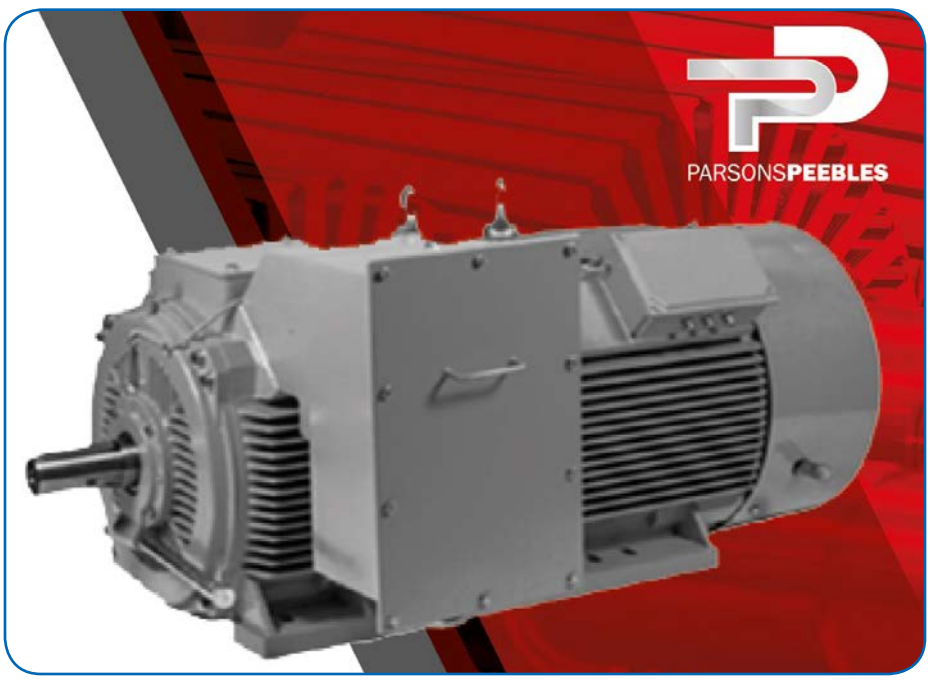
Parsons Peebles recently launched their new medium and high voltage standard motors extending their current portfolio of engineered and drop-in replacement solutions.

The main product types that will feature in the Parsons Peebles standard product portfolio include the PPD series, an IC411 motor which is a self-ventilating, enclosed machine with external fins and an external shaft mounted fan. The PPT Series is an IC611 motor which is also an enclosed machine and has a built on heat exchanger and shaft mounted fans. The PPC Series, an ICO1 motor, is a self-ventilating machine that is integral fan cooled by a shaft mounted fan. These all conform to the IC code as laid down in 60034-6.

The three-phase squirrel caged induction designs, come in a range of voltages, most commonly 3.3 kV, 6.6 kV and 11 kV with class F insulation and class B rise as standard. The product range covers 2 to 10 poles in sizes up to 560 frame, across a power range of 185 kW to 2.8 MW.

"We are excited at this next step in the continued development of the Parsons Peebles product offering to our customers. This launch is an important part of our journey, while continuing to enhance our reputation and brand as a full service and product provider across the whole electromechanical landscape," said Frank Barrett, CEO, Parsons Peebles Group.

For more information:
Parsons Peebles Group
Phone: +44 (0) 1383 421 150
www.parsons-peebles.com



Moticont

ADDS SERVO ACTUATOR TO SDLM SERIES

The new SDLM-019-070-01-01 direct drive linear motor is the latest addition to the series of zero backlash, zero cogging, high acceleration, high speed, high resolution, long life linear servo motors from Moticont. Also known as an electric cylinder, this compact direct drive linear motor is just 0.75 in. (19.1 mm) in diameter and 2.75 in (69.9 mm) long. Protected inside the motor housing, the linear optical quadrature encoder is directly connected to the shaft for the greatest possible accuracy. This direct drive linear motor features 1.25 µm (0.000049 in.) of resolution.

The SDLM-019-070-01-01 direct drive linear motor has a stroke length of 0.500 in. (12.7 mm) and a continuous force rating of 9.7 oz. (2.7 N) and peak force of 30.7 oz. (8.5 N). This non-commutated direct drive servo motor features: Quiet long life plain linear bearings, an integrated internal (1.25 micron resolution) quadrature optical encoder with differential outputs, and a non-rotating shaft. Some applications include: Manufacturing (assembly and inspection equipment), sorting and packaging, semiconductor handling, medical equipment and instruments, antenna positioning, dampers and valve actuators.

Direct coupling of the load or stage to the low inertia non-rotating shaft eliminates backlash and allows for high acceleration/deceleration. Both ends of the motor and shaft ends have threaded mounting holes for easy integration into new and existing applications. The SDLM-019-070-01-01 Direct Drive Linear Actuator is also available as a complete plug-and-play linear motion system with a matching motion controller.

For more information:
Moticont
Phone: (888) 785-1804
www.moticont.com

Boca Bearing

EXPANDS MOUNTED UNIT BEARINGS AND INSERTS

The Boca Bearing Company is proud to announce the expansion of their line of mounted unit bearings and inserts. Mounted unit bearings are used when a shaft axis is perpendicular to the bearing mounting surface. Available in 2 or 4-hole configurations, flange mounted unit bearings and pillow blocks provide a method of accurate mounting fits and load support.

Stainless steel mounted unit bearings are designed to meet all of the most demanding operating environments such as the medical, food, beverage or chemical industry. Stainless steel is ideally suited for applications that require frequent wash downs, operate near food or liquid contaminants and have a high exposure to harsh chemicals or humidity.

Boca Bearing also offers thermoplastic mounted unit bearings consisting of a high-grade, thermoplastic housing with a stainless steel insert. Full ceramic or ceramic hybrid insert bearings can be substituted upon request from a 0.5000 inch bore to a 1.5000 inch bore in both metric and inch sizes. Thermoplastic housings will never rust or corrode and characteristically exhibit excellent stiffness, mechanical strength and dimensional stability.

Also offered is the mini mounted unit bearings which have a rustproof housing made with a special alloy or stainless steel 304 with bearings made from high carbon chromium bearing steel or stainless steel 440C. Low profile mini mounted units are ideally suited for tight spaces. Pillow block and two bolt flange styles are available now. Selection of the appropriate bearing can be accomplished with knowledge of the shaft size and radial and thrust load requirements.

For more information:
Boca Bearing Company
Phone: (561) 998-0004
www.bocabearings.com

Brother Gearmotors

INTRODUCES LINE OF RIGHT ANGLE HYPOID GEARING BRUSHLESS DC GEARMOTORS

Brother Gearmotors, a division of Brother International Corporation that offers a wide range of ultra-reliable, sub-fractional AC gearmotors and reducers for the food & beverage, packaging and material handling industries, has introduced a line of Brushless DC electric gearmotors (BLDC). Also, known as Electronically Commutated Motors, Brother's portfolio of brushless DC gearmotors are ideal for environments requiring virtually maintenance-free operation and accurate speed control as well as operation over a wide speed range. They are also desirable for settings where brush dust contamination is to be avoided or brush contact arcing could affect electronically sensitive equipment. Features include several shaft configurations, custom options, maintenance free, lubricated and sealed for life as well as very Safe 12-48 VDC motors with a wide speed control range.

The new brushless motors are designed to work with an OEM's own design drive or standard brushless drives from Brother with features such as adjustable acceleration, deceleration, open or closed loop operation, current limiting and other performance and safety features.

"Brother Gearmotors is pleased to add this set of high-efficiency brushless gearmotors to our product offerings," said Matthew Roberson, vice president of Brother Gearmotors. "At Brother, we strive to provide our customers with the full array of gearmotors they need to remain both competitive and cost-effective."

For more information:
Brother Gearmotors
Phone: (908) 704-1700
www.brother-usa.com/gearmotors

SICK

ULTRASONIC FLOW SENSOR DETECTS FLOW VOLUME

The new non-contact DOSIC ultrasonic flow sensor from SICK is used to detect the flow volume of conductive and non-conductive liquids. With its measurement channel and stainless-steel housing, the ultrasonic flowmeter is suitable for measuring tasks in hygienic and highly demanding environments.

The rugged and compact model combined with a hygienic design ensures highly reliable measurement results. This makes the sensor ideal for a wide range of application possibilities, including those where space restrictions or aggressive media play a role.

Two configurable digital inputs and outputs and up to two analog outputs, as well as an IO-Link interface to a superordinate control unit, ensure that you get just the right start position. The IO-Link reduces cabling and also enables complete control and monitoring of the sensor in Industry 4.0 machine environments.

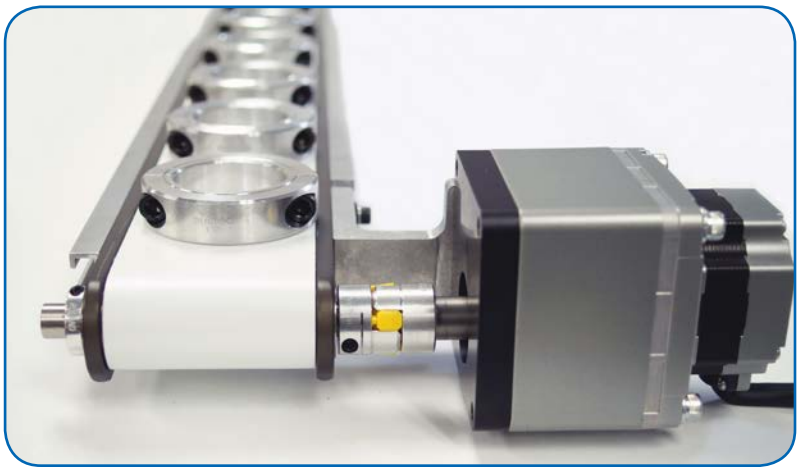
The absence of moving parts in the sensor eliminates potential contamination risks in the demanding hygienic environments of the food industry. In addition, the sensor has a straight, seal-free, and self-emptying measuring tube made of high-quality stainless steel (316L with Ra ≤ 0.8). The high-quality stainless-steel housing also provides the necessary ruggedness and resistance. It therefore goes without saying that the sensor has EHEDG certification and demonstrates FDA conformity. Since there is no contact between the sensor and the flowing media, and the flow volume is determined in a non-contact manner, aggressive cleaning agents in CIP and SIP operations are not a problem either. The sensor can easily withstand temperatures up to 143 degrees Celsius in SIP processes for up to one hour.

In addition, the sensor automatically adjusts its parameters if the medium is changed. This "Plug & Measure" solution eliminates the need for initial medium calibration and reduces installation and operating costs.

For more information:
SICK, Inc.
Phone: (800) 325-7425
www.sickusa.com

Ruland

JAW COUPLINGS UTILIZED FOR PRECISION CONVEYORS



Ruland zero-backlash jaw couplings have a balanced design, accommodate all forms of misalignment and have high dampening capabilities, making them an ideal fit for precision conveyors with frequent starts and stops. These conveyor applications are often found on equipment used in semiconductor, solar, optical inspection, and medical automation. Jaw couplings offer system designers a wide range of sizes and performance characteristics to fit their application requirements.

Zero-backlash jaw couplings from Ruland are made from two polished aluminum hubs and a spider type insert. The curved jaw profile of the hubs press fits to the spider, ensuring zero-backlash operation. Hubs are available in clamp or set screw style with inch, metric, keyed, and keyless bores. Spiders are available in three durometers: 98 shore A for high stiffness, 92 shore A for a balance of stiffness and compliance and 85 shore A for the highest amount of dampening. Conveyor designers can mix and match hubs and spiders to create a coupling that best fits the need of their application.

Ruland jaw couplings have a standard balanced design for reduced vibration at higher speeds which is critical for conveyors in applications such as rapid optical inspection where errors can be caused by slight deviations in expected positioning. Jaw couplings are considered fail safe because if the spider fails, the jaws on the two hubs will interlock with no loss of power transmission. This prevents the system from coming to an abrupt stop and damaging sensitive high value items such as semiconductor or solar wafers.

Ruland jaw couplings are made from bar stock sourced from select American mills and carefully manufactured in Ruland's factory in Marlborough, Massachusetts. They are available in bore sizes ranging from ⅛ inch to 1¼ inches or 3 mm to 32 mm. Stainless steel hubs and spiders with a center hole are available by request.

For more information:
Ruland Manufacturing Co., Inc.
Phone: (508) 485-1000
www.ruland.com

Rexnord

ANNOUNCES NEW INDUSTRIAL TORQUE MONITORING

The latest in industrial process torque measurement is now available from Rexnord. Monitorq is a robust and reliable torque measuring device which can be integrated into a driveline using standard power transmission products such as couplings, pulleys and gears. It provides a true measurement of torque, from any location in a drivetrain.

The innovative Monitorq system is comprised of a strain-gauged torque ring and an E-90 Sensor. The E-90 Sensor provides the torque ring with inductive power and receives a radio signal back from it. The radio signal is converted into an output signal proportional to torque that can be directly connected to a control system, or shown on a dedicated screen.

"The design of this latest version of Monitorq has been driven 100 percent by feedback from our customers," said Rob Hucker, product manager, Rexnord Shaft Management Solutions. "We have removed batteries from the torque ring and replaced them with a state-of-the-art inductive power system. We have also increased the accuracy of the torque signal to 1% of full-scale torque while at the same time increasing the sampling rate to 1 kHz. We're very excited to see the first Monitorq ship to customers."

Rexnord Monitorq enhances equipment performance by providing a variety of functions ranging from simple overload protection to production or process control and condition monitoring, as used in modern preventative maintenance systems.

For more information:
Rexnord
Phone: (866) 739-6673
www.rexnord.com/monitorq

R+W

OFFERS SPECIALLY-DESIGNED ST SERIES COUPLING FOR EXTRUDING EQUIPMENT

R+W has expanded its line of ST series safety couplings, with a specially designed version now available for the protection of extruding equipment. Taking advantage of the well-proven ball-detent safety element system, the driving and driven ends separate within milliseconds of a torque overload, protecting the extruder from damage and reducing expensive repairs and costly downtimes. The driveline is free to coast to a stop after disengagement, and re-engagement simply requires that a force be applied to the back sides of the plunger modules, either with a soft hammer or pry bar. A wide variety of disengagement torque values are available through a selection of adjustment ranges.

The safety couplings are designed with an integrated elastomer-jaw set, absorbing vibration and shock, as well as allowing for compensation for axial, angular, and parallel shaft misalignment.

Lateral mounting by means of the fully split clamping hubs simplifies the installation process and eliminates the need to move heavy motors and gearboxes during installation or removal.

For more information:
R+W America
Phone: (630) 521-9911
www.rw-america.com

Granite Devices Inc.

IONI SERVOMOTOR DRIVE PERFORMS MULTI-AXIS SYNCHRONOUS MOTION CONTROL

Granite Devices Inc., a Finnish servo drive manufacturer has released a new industrial servomotor drive contributing high degree of time and cost saving features to the machine automation market.

A "swiss knife of motion control" IONI starts a new era of servo drives by bringing snap-on installation, built-in SIL2 safety functions and unforeseen compactness in 700 W class in just 70 × 37 × 7 mm form factor.

IONI implements industry standard, torque, velocity and position controls for AC, brushless DC, brushed DC, linear servomotors and stepping motors between 2 W and 700 W power. An improved high dynamic range torque control allows seamlessly to connect a range of motor variants to a single drive type.

The real beauty of IONI is the ability to perform multi-axis synchronous motion control out of non-realtime host, such as Windows PC with USB or Ethernet connection. This has been achieved by the means of hardware side trajectory buffering and distributed clock synchronization. Customer's motion control software just fills drives' trajectory buffers to perform silky smooth multi-axis motion.

Under the hood, IONI packs an unforeseen level of connectivity. IONI Pro drive model holds all-inclusive support for incremental and sin/cos encoders as a standard feature. Drive connects directly to the fully open C/C++/C# programmable SimpleMotion bus as well as traditional digital pulse train and analog controllers.

IONICUBE and IONICUBE 1X motherboards are offered alongside with IONI drives for customers to build 1-4 axis solutions or larger motion control systems by chaining the motherboards. IONICUBE motherboard schematics are also offered in open source fashion for customers to build their own purpose-built motherboards.

"IONI has proven such swiss knife of motion control approach feasible by using today's latest technologies" says company's product architect Timo Piiroinen. IONI is available worldwide directly through Granite Devices web shop immediately from the stock.

For more information:
Granite Devices Inc.
Phone: +358 44 99 175 33
www.granitedevices.com

OES

INTEGRATES LINEAR STAGE SERIES INTO NEW AND EXISTING APPLICATIONS

OES (Optimal Engineering Systems) offers ten high precision, low cost linear positioning stages that can be easily integrated into new and existing applications. Choosing the best slide for the application is easy. The five AQ120 and five AQ130 series of linear motorized stages are available in travel distances of: 50 mm (1.969 in.), 100 mm (3.937 in.), 150 mm (5.906 in.), 200 mm (7.874 in.), and 300 mm (11.811 in.). The compact, AQ120 series of linear stages features high precision steel linear ball bearings and hardened steel shafting and are designed for loads of 15 kg (33.1 lbs) for the AQ120-50 to 5 kg (11 lbs) for the AQ120-300. The AQ130 series of linear stages features high precision open steel linear ball bearings and supported hardened steel shafting and is designed for loads to 30 kg (66.1 lbs) for all travel lengths.

Each of these black anodized slides features a large table with a pattern of threaded mounting holes, and a precision low backlash (2 µ) 4 mm per turn lead screw. The resolution for all slides is 2 microns per pulse using a10 microsteps per step motor driver, or just 1 micron per pulse using a 20 microsteps per step motor driver. These stages can easily be configured as XY stages, with a Z axis, or with a rotary, lift, or goniometer stage. All stages are also available with a servo motor and optical encoder, and are compatible with OES' line of motion controllers. Options also include: plug-in motor driver / indexer, stepper motor with an optical encoder for position verification.

For more information:
Optimal Engineering Systems, Inc.
Phone: (888) 777-1826
www.oesincorp.com

Gear Expo 2017 Booth Previews

All you need to know about who's there.

Alex Cannella, Associate Editor

Gear Expo 2017
October 24–26,
Greater Columbus Convention Center,
Columbus, OH
www.gearexpo.com

GEAR EXPO 2017
THE DRIVE TECHNOLOGY SHOW

AA Gear & Manufacturing

Booth 937

AA Gear & Manufacturing, Inc. is a vertically integrated batch manufacturer of complex splined shafts and helical/spur gear components produced out of carbon steel alloys servicing the construction, agricultural, mining, automotive, industrial, marine, petrochemical and on/off highway diesel engine markets in North America and throughout the world. They take pride in their manufacturing ingenuity to process these complex components in the most efficient processing steps through finished gear profiles utilizing form and generating gear teeth grinding capabilities.

AA Gear's in-house capabilities allow them to get involved with projects upfront as soon as the proof of concept phase and take them through serial production launch and support. They also assist in manufacturability assessments to support their customers in designing the most optimal components for their rigorous applications.

Whether it's a bar stock or forging application, AA Gear provides complete processing services for your components, including: CNC turning and milling, hobbing, shaping, shaving, gear chamfering, spline rolling, broaching, gun drilling, wire EDM, CNC jig grinding, ID/OD grinding, form and generating gear teeth grinding, vertical honing, lapping and light assembly. They also utilize two labs for support metrology inspections that include Sigma 3 and Klingelnberg Gear and Shaft Analyzer Equipment. This gives AA Gear the ability to produce gears to AGMA 2000 Q-12/AGMA 2015 A-4 quality levels.

For more information:
AA Gear & Manufacturing, Inc.
Phone: (517) 552-3100
www.aa-gear.com

Arrow Gear

Booth 1201

Arrow Gear has been manufacturing precision spiral bevel, straight bevel, zerol bevel, curvic couplings, spur, helical and internal gears and gearboxes for 70 years. Arrow Gear serves many different industries, including aerospace, government, mining, oil/gas, food/medical, agriculture, power tools and machine tools to name a few. While their name is synonymous with the aerospace industry for both planes and helicopters, they have been serving several of the industrial markets for many years.

Arrow Gear has a state of the art, 145,000 manufacturing facility with the latest technology in cylindrical and bevel gearing. Remaining on the forefront of the precision gear industry requires continual reinvestment in advanced technology. Arrow Gear has a longstanding tradition of integrating the latest technology to enhance productivity and competitive pricing while offering the highest quality available. As a result, Arrow Gear is among the most technically advanced facilities in the world for the manufacture of high precision gears.

In an effort to expand Arrow Gear's product range, they have partnered with a European supplier which allows them to offer gears to many additional industries. These industries include robotics, textile, railway, printing, pumps, forklifts and antennas. Stop by the booth to learn more about Arrow Gear's new look, new machines and new products!

For more information:
Arrow Gear Company
Phone: (630) 969-7640
www.arrowgear.com

ASI Drives

Booth 630

ASI Drives is a custom manufacturer of gear drives for battery-powered vehicles and equipment. They specialize in machines that carry between 400 and 2,000 pounds, but have designed products for machines that carry between 50 and 6,000 pounds and can produce between 50 watts and 1.5 kilowatts. ASI has decades of experience in gear design. They cut all their gears in-house to their specifications. They can streamline the engineering process by solving your engineering problems, saving time on your product launch cycle. They have a full understanding of the entire process, from sketches to production. ASI strives to be as flexible as possible in order to meet your specific needs.

ASI will be displaying its new shop bot, which will demonstrate their capabilities to design and build an AGV for your factory floor. The bot has a custom-built frame, with two wheels designed to minimize wear and one castor wheel for increased mobility. It's been programmed to follow a path laid out by panels on the ground. ASI will also be bringing a number of product samples to Gear Expo. We'll have products from our families of transaxles, wheel drives and right angle drives, along with some custom designs.

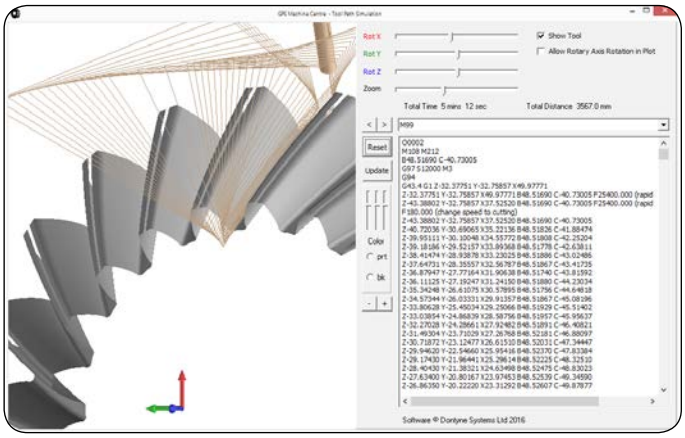
For more information:

ASI Drives
Phone: (215) 661-1002
www.asidrives.com

Dontyne Systems

Booth 123

Dontyne Systems continues to develop an ideal platform for integrated gear design and manufacture through new and improved functionality to the *Gear Production Suite* (*GPS*).



Simulations for hobbing, continuous grinding with dressing, shaping, shaving and profile grinding have been successfully implemented in many companies now, and have been continually improved to produce high correlation with production. Accurate modeling of the processes allows for automatic tool design, including assessment of the effects of tolerancing, before cutting metal. This gives more confidence in right-first-time production for reduced waste of time and resources. The technology has been proven to give accurate results using both standard gear production equipment and flexible 5-axis production systems. Utilizing multiple operations and existing tooling in a multi-axis machine makes it ideal for prototyping and small batch production including bevels. *GPS* design functions enable designers to optimize tooth contact in our LTCA model before machining. The interface to these machines now includes exporting G-code to reduce setup time.

Trials have shown interfacing to dedicated gear inspection and CMM units further improves production efficiency and quality. Measurement data can be used to edit axis position for accurate surface generation or the tool surface itself including forming processes such as forging and injection moulding.

Integration of the software enables constant monitoring and correction of production, which could be automated. Considerable savings in time and cost are possible. Dontyne will be demonstrating some examples of their ability to integrate their design tools with manufacturing from Mazak and inspection equipment live at Gear Expo Booth 123. They look forward to discussing how their software can help improve production efficiency and flexibility with your existing or developing production systems.

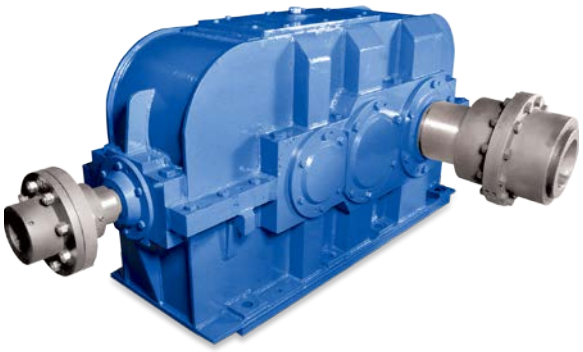
For more information:

Dontyne Systems Limited
Phone: +44 (191) 206-4021
www.dontynesystems.com

Esenpro/Essential Power Transmission

Booth 745

Esenpro, a brand of Essential Power Transmission Pvt. Ltd., is one of the leading manufacturers and exporters of industrial gearboxes and open gears. They are in the business of designing, manufacturing and servicing gearboxes and gears. Esenpro has multiple institutions globally in the steel, cement, plastic, mining, power, overhead cranes, port and chemical industries. They have in-house designing, machining, gear grinding, metrology, calibration and heat treatment facilities.



Esenpro offers its products both in standard and customized categories. In particular, Esenpro's revenue generator is its customized gearbox, which is growing year on year, providing it a definite edge over its competitors. Esenpro standard gearboxes are helical gearboxes, bevel helical gearboxes, worm gearboxes, crane duty gearboxes, cooling tower gearboxes, extruder gearboxes, rolling mill gearboxes and aerator gears and gear assemblies. Also, open gears as per customer design and special gearboxes for crane, power, steel, paper, and mining industries.

Esenpro also undertakes reengineering of existing/old gears and gearboxes for any plant and machinery to enhance their capacity to withstand higher speed, feed and load within the existing mounting dimensions. Esenpro also designs and supplies drop in replacement gearboxes. These gearboxes exactly replace the old gearbox without an inch of modification to the existing foundation. Esenpro also has a separate engineering team to develop planetary gearboxes for steel, power, sugar, material handling and mining.

Esenpro has always given priority to quality. Steel round bars and blanks are sourced from reputed forging companies in India. The material undergoes a series of quality checks to

ensure the gearbox is reliable. The gearbox housing is provided in either CI or M.S Fabricated. Gearbox housings are duly stress relieved and shot blasted. Other bought out materials such as bearings and oil seals are directly procured from reputed manufacturers. Esenpro's machine shop is equipped with the latest CNC machines for machining, boring, drilling, planning and grinding operations. They are also commissioning our heat treatment facility by the end of 2017.

For more information:
Esenpro
Phone: +91-9920828403
www.esenpro.com

Exsys Tool

Booth 1704

As a long time Eppinger supplier, Exsys Tool offers a line of high-quality Eppinger Spiral Bevel Gearboxes. Eppinger's BT (bevel torque) and BM (bevel maximum torque) compact spiral bevel gears deliver high torque and maximum efficiency for gear applications that require extreme reliability and variability at speeds over 1,000 rotations per minute, as is the case for vehicle differentials.

Each of these bevel gearbox types offer minimized tooth clearance and optimal transmission properties via precision axes and bearing seats combined with Gleason bevel gears that can withstand high loads.

The single-component steel housings for these bevel gearboxes feature mounting threads on all sides to ensure stable attachment in a variety of installation positions. The heavy-duty bevel gears inside these housings offer high-transmission precision and reduced stress on the bearings. A friction-locked, zero backlash connection of the crown gears on the drive shaft reduces the mass of the gearing component.

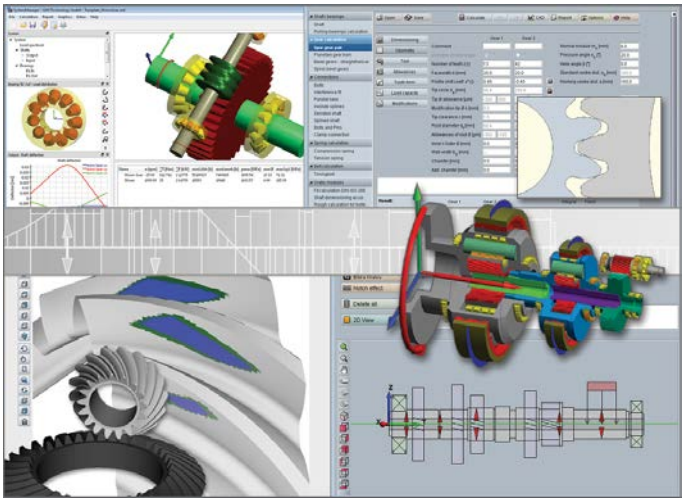
Both BT and BM gearboxes come in solid or hollow shafts in standard and custom designs. BT-type models are available in seven sizes with a transmission ratio of i = 1:1 to 5:1, while BM-type models are available in five sizes with a ratio of i = 1:1.

For more information:
Exsys Tool
Phone: (800) 397-9748
www.exsys-tool.com

GWJ Technology

Booth 944

Focusing on mechanical engineering, GWJ Technology stands for high-quality products and professional software development for mechanical engineering to support engineers and designers in their daily work. The GWJ product range of innovative calculation software is wide — from standard software for classical machine elements with 3D CAD integration modules to the determination of whole systems up to a complex special software for 5-axis milling of gears. There are common features that all GWJ solutions share: intuitive design, sleek interface, ease of use and suitable applications for all users from beginner to very advanced. GWJ is constantly working on software enhancements and adding new features to the system in order to keep the applications up-to-date. They are also committed to providing high-quality customer services, including engineering services and workshops.



Several of GWJ's various software suites will be on display. eAssistant is a web-based calculation software for mechanical engineering. The software allows for professional calculation, design and optimization of machine elements including shafts, bearings, cylindrical gears, bevel gears, shaft-hub connections plus many more. The suitable 3D CAD plugins offer a great way to connect calculation and design. 3D CAD models can be automatically created with just a mouse click and the design table with all manufacturing details can be placed on the manufacturing drawing.

For more than 30 years, the *TBK* software has been a widely accepted calculation software and is being successfully used by many engineers worldwide in the widest range of sectors. Gear manufacturing is one of the key applications. The software is used in the steel and cement industry, open cast mining, wind turbines and even for Formula 1 engines. The high-quality calculations are based on generally accepted calculation methods (DIN, ISO, VDI, AGMA, ANSI, etc.).

SystemManager is a true software application for complete systems of machine elements. The software is a coupled FE calculation of multi-shaft systems with gears as non-linear coupling elements. *SystemManager* runs as a desktop application, making it possible to configure and calculate entire

systems with just a few mouse clicks. The application ranges from simple to complex systems, e.g. multi-stage gearboxes, shift gear transmissions or different types of planetary gear trains. *SystemManager* allows the import of 3D housings as STEP files. The software meshes the parts automatically to consider deformation and stiffness of the housing throughout the system. A further extension of the 3D elastic parts function is the support of planet carriers and imported shafts. Planet carriers can be imported as CAD models or be defined parametrically; various basic designs are available for the parametric planet carriers.

The *TBK Manufacturing Suite* is a powerful software especially designed for calculating the real 3D geometry of gearings. This geometry provides the basis to manufacture cylindrical and bevel gears in conjunction with multi-axis machining centers. The software calculates the tooth form based on a mathematical simulation of the manufacturing process analogous to traditional manufacturing on gear cutting machines. The *TBK Manufacturing Suite* is one of the world´s leading and award-winning software products in this field.

For more information:
GWJ Technology
Phone: +49 (0) 531 129 399 0
www.gwj.de

Innovative Rack & Gear

Booth 615

Innovative Rack & Gear will be displaying their newest addition to their current gear rack capabilities — Gleason-Saikuni's HR-2000: a CNC rack milling machine capable of hard-milling rack teeth after heat treat with hardness of up to 65 Rc and producing tooth finishes and accuracies comparable to rack grinding. Also on display will be some of the sample work they have done for their customers in various industries, including the automation, aerospace, computer, construction, mining, oil, defense, machine tool, medical and repair industries.

Innovative Rack & Gear's capabilities include straight and helical racks in various materials, both metric and American standards as well as unique tooth configurations, from fine pitch (254 D.P./0.1 Module) to coarse pitch (0.50 D.P./50 Module), up to 32" (812 mm) face width and up to 288"(7300 mm) lengths* (*through resetting). They also provide secondary operations via their CNC Machining Centers. Their Wenzel CMM is our newest addition this year to their current gear rack inspection capabilities.

For more information:
Innovative Rack & Gear Co.
Phone: (630) 766-2652
www.gearacks.com

McInnes Rolled Rings

Booth 1248

McInnes Rolled Rings specializes in seamless rolled rings from 4"–144" diameter and forged discs up to 54" diameter in carbon, alloy and stainless steel. Their ISO 9001, AS9100 and ABS certified plant in Erie, Pa. combines the latest in ring rolling technology with experienced professionals, resulting in the best value and the fastest deliveries in the industry.

For more information:
McInnes Rolled Rings
Phone: (800) 569-1420
www.mcinnesrolledrings.com

Mijno Precision Gearing

Booth 231

Mijno's line of custom and standard low-backlash planetary gearheads has achieved max backlash from 1 to 30 arc-mins and ratios from 3 to 1000/1. In-line, right-angle and "rotating flange" gearboxes which according to Mijno remain second-to-none in stiffness, quietness, reliability and long life and are capable of up to 12,000 Nm of torque. They also manufacture ground rack and pinion (linear gearing) as well as build-to-print metal and plastic components with gear features. Custom gearboxes are Mijno's specialty, with products available worldwide.

As a world leader and custom manufacturer of planetary gearheads, low-backlash reduction power transmission as well as racks and pinions, they have the solution for your servo-application. If they don't then they will custom design and build it for you. In addition to custom designs, Mijno can also manufacture according to your prints. Mijno's cataloged gearboxes and gearheads can be applied with a large variety of electric servomotors: however, some choices can optimize your application.

If it's high quality gears, internal or external in small to medium quantities, Mijno's expertise of 90 plus years will fulfill your requirements.

For more information:
Mijno Precision Gearing USA
www.mijno-usa.com
Phone: (707) 321-4447

Napoleon Engineering Services

Booth 532

Napoleon Engineering Services specializes in custom bearing manufacturing and has invested heavily in their custom bearing manufacturing capabilities over the past year to satisfy increasing demand.

"Our goal is to provide our customers quality products with the shortest lead times possible. With the investments in our new 22,000 sq ft facility and increased machining capabilities we are looking forward to continuing that commitment of speed and quality," stated president and chief engineer, Chris Napoleon.

On average, NES' lead times for custom bearings range from 8–12 weeks with manufacturing capabilities encompassing a number of specialty ring materials, cages, rolling elements and coatings for use in a wide range of applications. Napoleon Engineering Services performs all manufacturing, testing and inspection services from its ISO 9001:2008 certified facility in Olean, NY.

For more information:

Napoleon Engineering Services
Phone: (877) 870-3200
www.nesbearings.com

Nichiei

Booth 408

Nichiei Company is a unique custom injection molder, specializing in ultra-precision components, including gears, bearings and gerotors. Gears as small as 2 mm and as precise as .15 mm module have been molded, meeting JGMA grade 0 requirements, which correlate to AGMA grades 13-14. Many applications involve metal replacement, providing lower cost, lighter weight, parts consolidation and improved performance (less noise, better corrosion resistance, etc.). Target markets include automotive, office equipment and medical devices and materials span the entire range of plastics, from acetal and nylon to Polysulfone and Polyetherimide (Ultem), all the way to PEEK and Polyamideimide (Torlon).

Nichiei has developed this expertise over a 30 year period and has learned that the key to their success is offering a fully integrated solution, from material recommendation, to mold flow analysis, to mold design and manufacture, to prototyping and production and then to final part inspection.

Come visit Nichiei to see examples of these parts with challenging geometries, including concave worm wheels, extremely fine pitch gears and even the 2 mm microgear molded out of carbon-filled PEEK which can be viewed under a microscope.

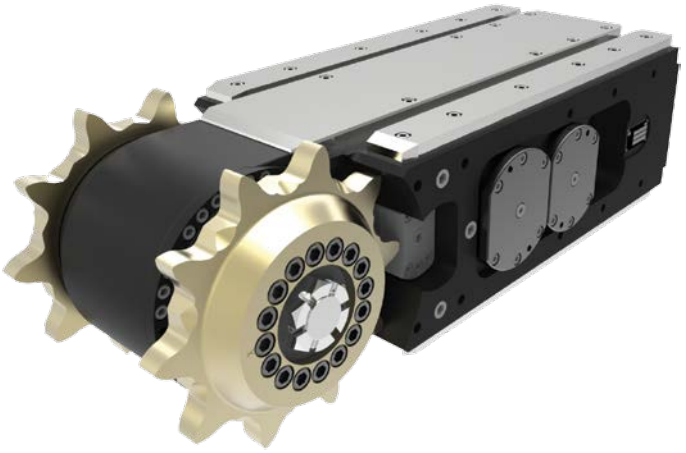
For more information:

Nichiei Company, Ltd.
Phone: (973) 729-2355
www.nichiei-ind.com

Oerlikon Drive Systems

Booth 915

Oerlikon Drive Systems, a part of the Swiss-based Oerlikon Group, is a leading supplier of high-precision gears, drives and shifting solutions. Under its market-leading brands of Oerlikon Fairfield and Oerlikon Graziano, the segment provides gears, splined shafts and components, synchronizer assemblies, planetary drives, transmissions and custom gearboxes for a wide range of applications, including sports cars, hybrid and electric vehicles to machinery and equipment for agriculture, construction, mining and energy production.



A variety of custom gears, shifting solutions, final drives and transmissions will be shown at the show. Specific end-use applications on display will include a track drive for a compact track loader, a swing drive for a ladder truck, tram and shuttle car drives for underground mining, integrated hydraulic and electric planetary final drives, a generator set with step up gearing for off highway hybrid-electric vehicles and innovative transmission designs that extend the range of electric passenger vehicles.

For more information:

Oerlikon Drive Systems
Phone: +39 011 9570 1
www.oerlikon.com/en/company/company-overview/segments-drivesystems

Power Transmission Engineering

Booth 1022

Stop by throughout the show to see live interviews with technical experts, product specialists and innovators from a wide variety of gear and power transmission-related companies. Watch and listen as our editors gather information for upcoming articles and take advantage of the opportunity to ask questions of your own from the suppliers you want to know more about.

Also, if you really want to get into the technical details of gears, stop by at 10:30 a.m. or 2:30 p.m. on Tuesday, October 24 or Wednesday, October 25. That's when we're hosting live sessions of our popular "Ask the Expert" column. We've assembled the brightest technical experts in the gear industry to provide you with gear design insight, manufacturing know-how and decades of their own experience. **PTE**

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ASK-THE-EXPERT LIVE!

ASK the EXPERT LIVE is coming to Gear Expo 2017 in Columbus, OH. This is your chance to have your questions answered in person by our live panel of experts.

See our expert at: **Gear Expo Booth #1022.** October 24–26

Tuesday, October 24

- 10:30 a.m. – Cylindrical Gear Cutting: Hobbing, Shaping and Skiving
- 2:30 p.m. – Gear Design, Standards and Software

Wednesday, October 25

- 10:30 a.m. – Gear Inspection
- 2:30 p.m. – Ask Anything

Can't wait? Submit your question now!

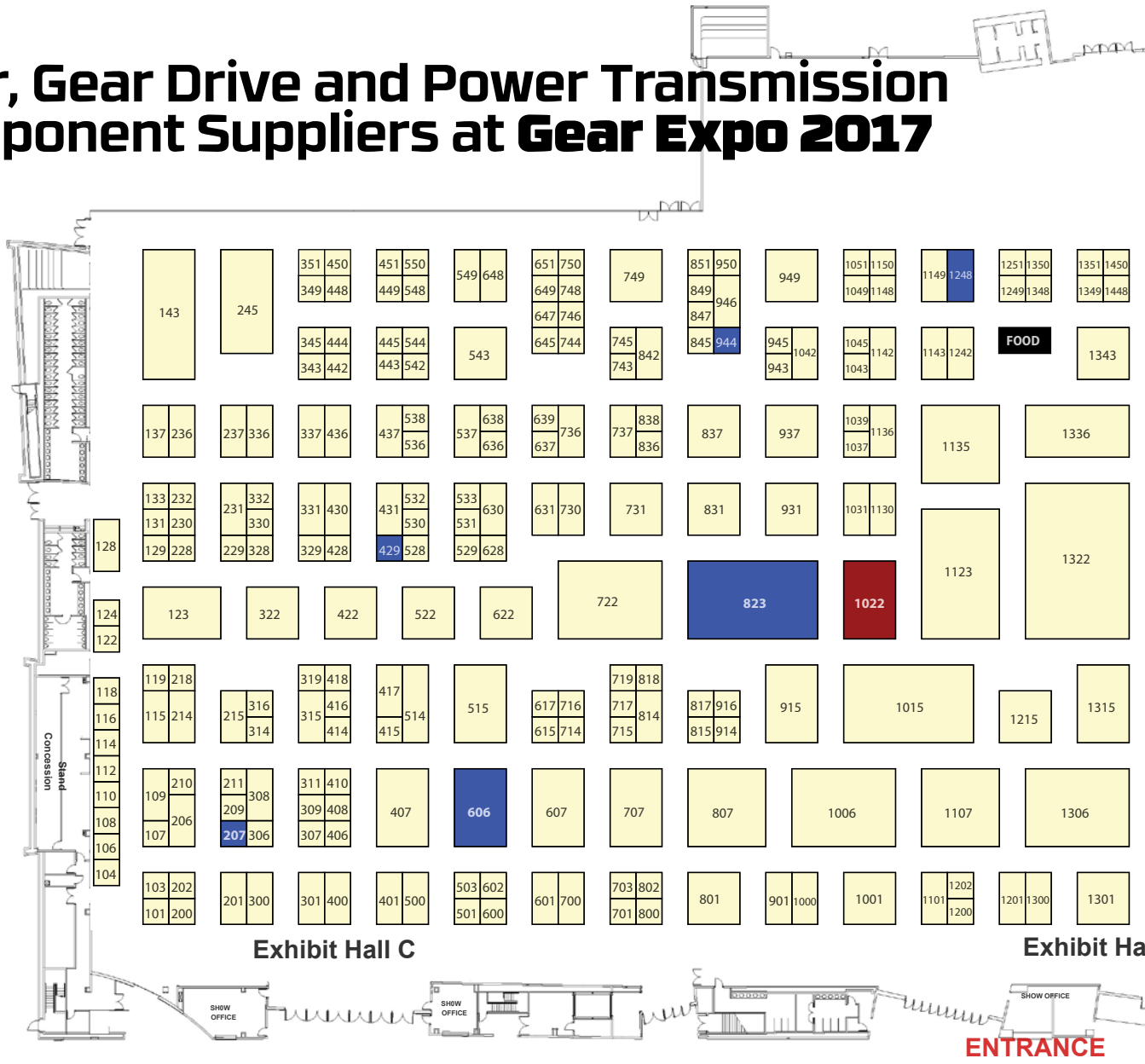
Send it by e-mail to Senior Editor Jack McGuinn (*jmcguinn@geartechnology.com*) and we'll submit it to our experts.

Power Transmission Engineering

www.powertransmission.com

VISIT US AT BOOTH #1022

Gear, Gear Drive and Power Transmission Component Suppliers at **Gear Expo 2017**



Company	Website	Booth #	Ad
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Affolter Technologies SA	www.affelec.ch	537	
AGMA	www.gearexpo.com	823	p9
Ancon Gear & Instrument Corp.	www.ancongear.com	800	
Anmark	www.anmark.com	106	
Ansol	ansol.us	1724	
Arrow Gear Company	www.arrowgear.com	1201	
Artec Machine Systems	www.artec-machine.com	1600	
ASCO Sintering Co.	www.ascosintering.com	207	p28
ASI Drives	www.asidrives.com	630	
Atlantic Bearing Services	www.atlantic-bearing.com	133	
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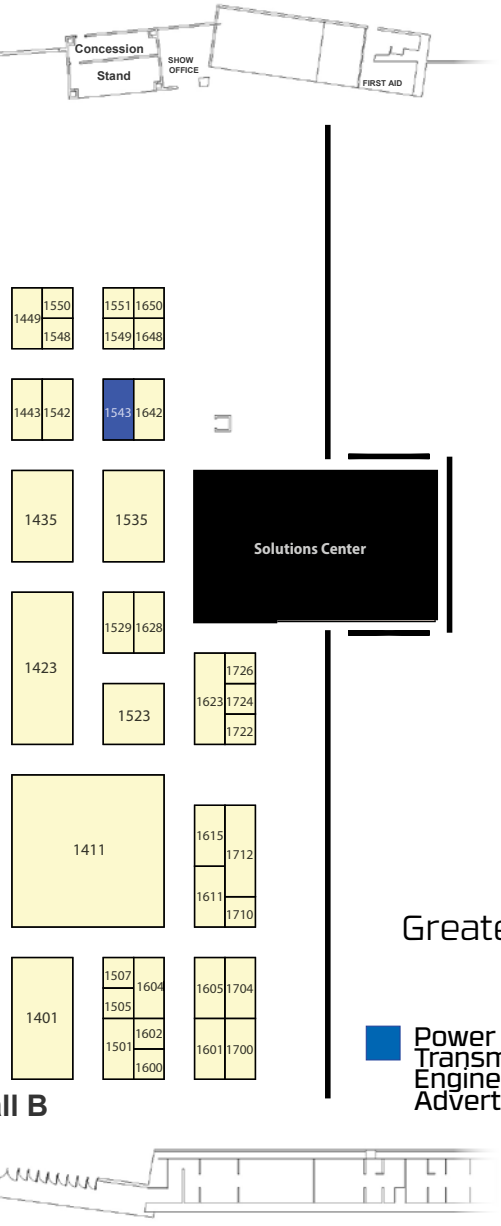
CGI Inc.	www.cgimotion.com	707	
Chao-Chia Gear Industry Co. Ltd.	www.chaochia.com.tw	343	



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GEAR EXPO 2017
THE DRIVE TECHNOLOGY SHOW

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Gear Technology magazine	www.geartechnology.com	1022	p27

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GWJ Technology GmbH	www.gwj.de	944	p28
Hanho America	www.hanhoinc.com	218	
Innovative Rack & Gear Co.	www.gearacks.com	615	
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Klingelnberg	www.klingelnberg.com	1123	
McInnes Rolled Rings	www.mcinnesrolledrings.com	1248	p16
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Metalcastello	www.metalcastello.com	115	
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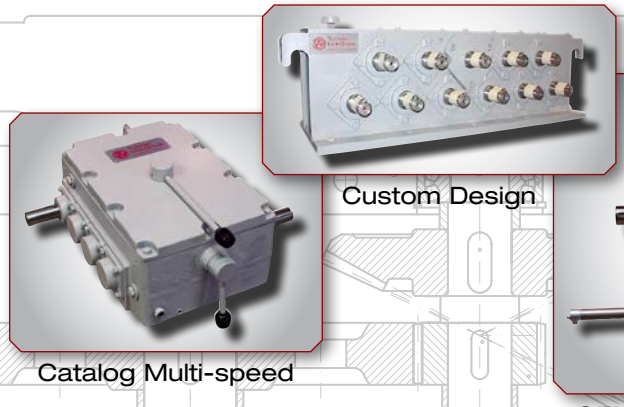

The Reliability of Sewer Robots

Faulhaber Provides Motor Technology for Pipe Renovation Projects

Faulhaber Austria GmbH

To the average driver waiting for the green light, the busy intersection in the heart of the city looks no different from any other morning. They have no idea that they are in the middle of a building site — or on top of one to be more precise.

Just a few meters below a dazzling beam of light cuts through the darkness and startles the underground "inhabitants." A camera lens is transmitting images of wet, cracked walls to the surface where the operator watches his monitor while he controls the robot. Not a scene from a science-fiction or horror film, but modern everyday life in sewer renovation. Motors from Faulhaber are used for camera control, tool functions and the wheel drive.

The days when conventional construction teams went to work on the sewer system, digging up roads and crippling the traffic for weeks are a thing of the past. It is much more pleasant if the inspection and renovation of the pipes take place below ground. Today, sewer robots can perform many tasks from the inside. They play an increasingly important role in the maintenance of urban infrastructure — ideally without disturbing the life that transpires just a few meters above them.

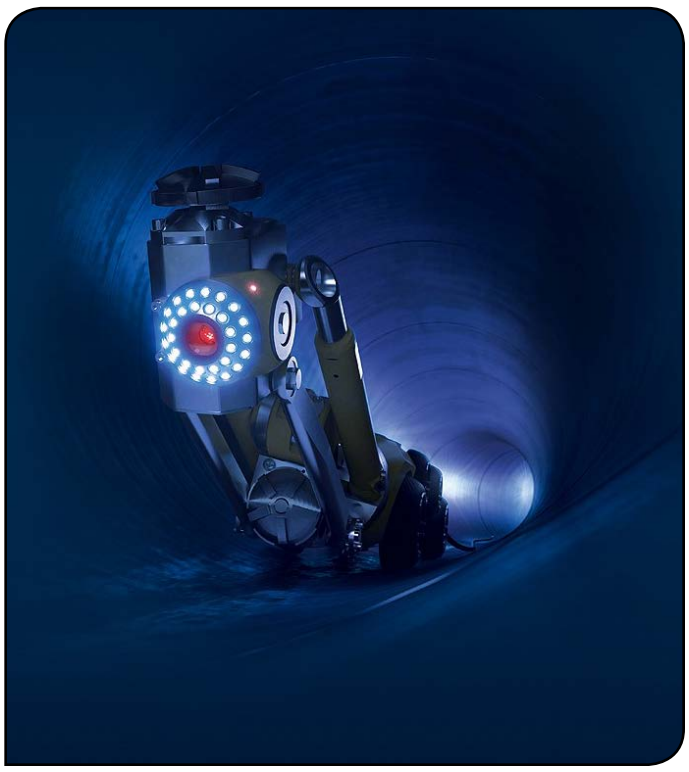

Figure 1 In the past, it was necessary to expose underground pipelines over long stretches just to localize damage. Today, sewer robots perform the assessment with no construction work at all (courtesy of Regelmann).

Robots Replace Excavators

It was previously necessary to expose underground pipelines over long stretches just to localize damage. Today, sewer robots perform the assessment with no construction work at all. They are guided into a pipe at a gully or house connection. A built-in camera inspects the inner wall of the pipe to localize the damage. If robots are equipped with so-called working heads, they can also perform many repairs immediately.

"There are different kinds of sewer robots," said Regina Kilb, who analysed this growing market segment at Faulhaber. "The devices for pipes with small diameters, usually shorter house connections, are attached to a cable harness. They are moved by rolling this harness in or out. They are equipped only with a swivelling camera for damage analysis. For large pipe diameters, on the other hand, machines mounted on carriages and equipped with multifunctional working heads can be used. Such robots have long been available for horizontal and, more recently, vertical pipes. The trend is towards smaller sewer robots, by means of which smaller diameter pipes can also be examined. In general, the field of application for sewer robots can be defined according to the pipe diameter: too large for push cameras, but too small for people."

The most commonly used type of robot is designed for straight, horizontal travel in sewers with only a slight gradi-

ent. These self-propelled robots consist of a chassis — usually a flat cart with at least two axes — and a working head with integrated camera. Another version is able to navigate bends in the pipe. Lastly, there are robots that can even move in vertical pipes because their wheels or crawler tracks press against the pipe wall from the inside. A moveable suspension on the frame centers the device in the middle of the pipe; the spring system compensates for irregularities as well as small cross section changes and ensures the necessary traction.

These and other sewer robots are used not only in sewer systems, but also in industrial pipeline systems, such as in the chemical, petrochemical or oil and gas industries. "The requirements on the motors in the chassis are very high," said Kilb. "They must pull the weight of the cables that supply them with power and transmit the camera images. For this purpose, the robots require motors that deliver very high power with minimal dimensions."

Figure 2 Regina Kilb, process engineer with Faulhaber (courtesy of Faulhaber).

Working in the Pipe

Sewer robots can be equipped with very versatile working heads for automated repairs. They are able to eliminate obstacles, incrustations and deposits or protruding sleeve misalignments through, e.g., milling and grinding. They fill small holes in the pipe wall with a sealing compound carried on-board or bring a sealing plug into the pipe. On robots for smaller-diameter pipes, the working head is located directly at the end of the carriage; on machines for larger pipes, this is located at the end of a moveable arm.

In such a sewer robot, up to four different drive tasks are therefore handled: for the wheels or the crawler tracks, for the movement of the camera, for the drive of the tools and for the moveable arm that moves them into position. With some models, a fifth drive is used to adjust the camera zoom.

The camera itself must be swivelled and rotated so that it can always supply the desired viewing angle. The camera bracket does not provide much space, which is why particularly small, yet very precise, motors are needed here.

Options include the flat and, measuring just 12 mm, extremely short gearmotors of the 1512…SR series or even larger models of the 2619…SR series. Faulhaber's wide range of products also includes stepper motors or brushless drives with diameters from 3 mm as well as the corresponding gearheads. "With respect to their size, these drives achieve the highest efficiency and energy density that is available," Kilb said.

Heavy Cable-Drag

This ratio plays an important role on the chassis as well, particularly as the trend is towards miniaturization to enable the devices to be sent into even smaller pipes. The design of the drive varies: the entire carriage, each axis or each individual wheel can be moved by a separate motor. Not only must the motor or motors move the chassis and attachments to the

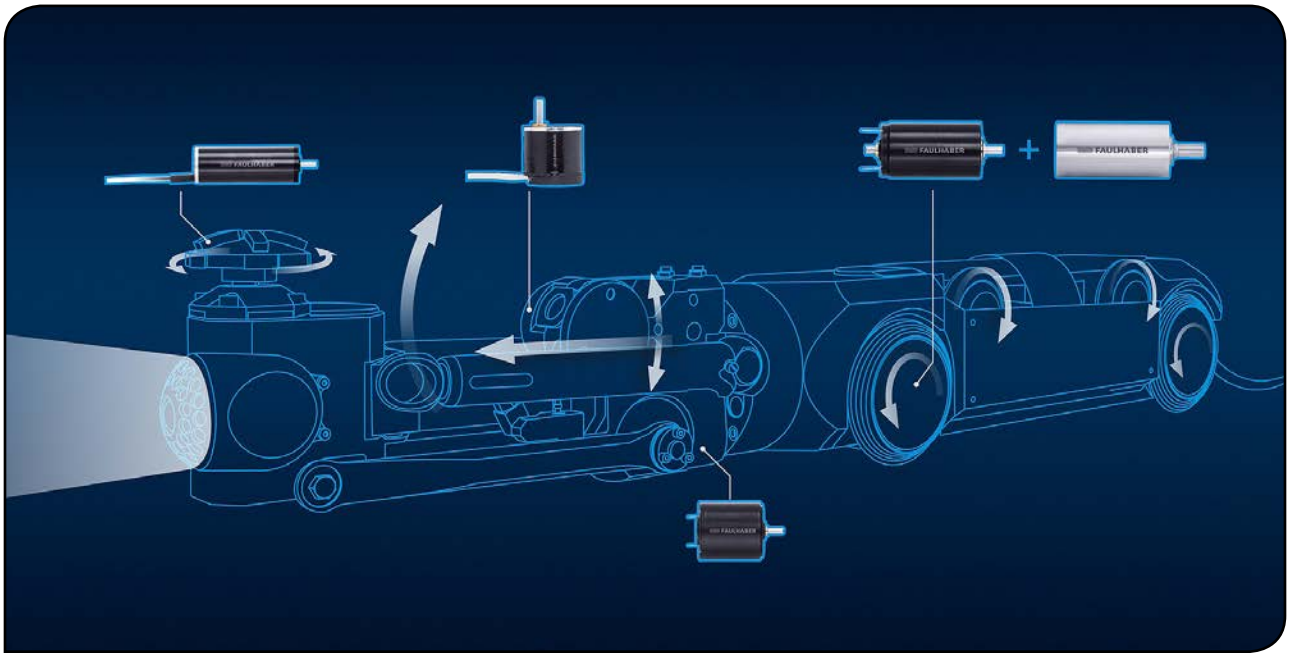

Figure 3 In a sewer robot, up to four different drive tasks are handled for the wheels or the crawler tracks, for the movement of the camera, for powering the tools and for the moveable arm that moves them into position. With some models, a fifth drive is used to adjust the camera zoom (courtesy of Faulhaber).

point of use, they must also pull along heavy pneumatic or hydraulic lines in addition to the electric cable.

With a range of up to 2,000 meters, the result is a cable drag of considerable weight. Thus, the drive must produce a very high torque, according to Kilb.

"At the same time, movement is time and again impeded by an obstacle. Overload at full speed occurs regularly. This is something that only very robust motors and gearheads can withstand. For this type of use, we recommend the proven graphite-commutated 3257 of the CR series or the 2224 of the SR series with precious-metal commutation and the new gearheads of the 20/1 R and 26/1 R types. The motor can be equipped with radial pins to secure the suspension and to absorb the forces that arise during overload," Kilb said.

Figure 4 The graphite-commutated motor 3257 of the CR series or the 2224 of the SR series with precious-metal commutation can be equipped with radial pins to secure the suspension and to absorb the forces that arise during overload (courtesy of Faulhaber).

The motor for the robot arm requires less force than the radial drive and has more space than the camera version. The requirements on this powertrain are not as high as on the others in the sewer robot. "For this task, we have a very wide range of standard motors available," Kilb added. "Among them is the optimum solution for every variant."

Compact Power Pack

The drives for the tools, on the other hand, must consistently deliver maximum performance — with small dimensions, since space is always limited in the function head. At the same time, motors that offer a particularly large amount of force and can operate trouble-free for a long time are needed for powerful gripping or for hours of milling.

They must also hold their ground against the competition posed by pneumatic and hydraulic drives. Due to the design, these produce higher torques than are possible using electrical drives in sewer conditions.

However, the electric motor needs neither the additional hydraulic or pneumatic drive unit nor the heavy and expensive lines and instead requires only the power cable, which is present in any case. The performance of the motors is increasing constantly, thanks not least of all to the knowhow and the ongoing development work of the engineers at Faulhaber.

"Motor type 2057…BHS, for example, is developed for such milling heads and achieves speeds in excess of 30,000 rpm," Kilb said. "This tool plays a very important role in pipe-in-pipe renovations, as it ensures the free flow between the side and main pipe."

Pipe in Pipe

Today, damaged sewage pipes are often not replaced, but rather lined on the inside with plastic. For this purpose, a plastic tube is pressed into the pipe with air or water pressure. To harden the soft plastic, it is subsequently irradiated with UV light. There are, in turn, specialized robots equipped with high-power lamps that move through the pipes for this purpose. After they perform their work, the multi-purpose robots with working head must move in to cut out the lateral branches of the pipe. This is because the hose initially sealed all inlets and outlets of the pipe. During such applications, one opening after the next is milled into the hard plastic, often over the course of hours. The service life and reliability of the motors are of decisive importance here to allow work to be performed uninterrupted.

"With us, the manufacturers of sewer robots find a wide range of products that offers a suitable motor for all of the different tasks in this sector," said Kilb. "This applies both with respect to power and efficiency as well as to robustness. Furthermore, we are available to our customers as a development partner if, for example, parallel positioning of the motor and gearhead is required for the camera movement. Together with our customers, we develop specific solutions for special requirements. These products do their part in increasing the amount of sewage work that is performed underground without construction crews." **PTE**

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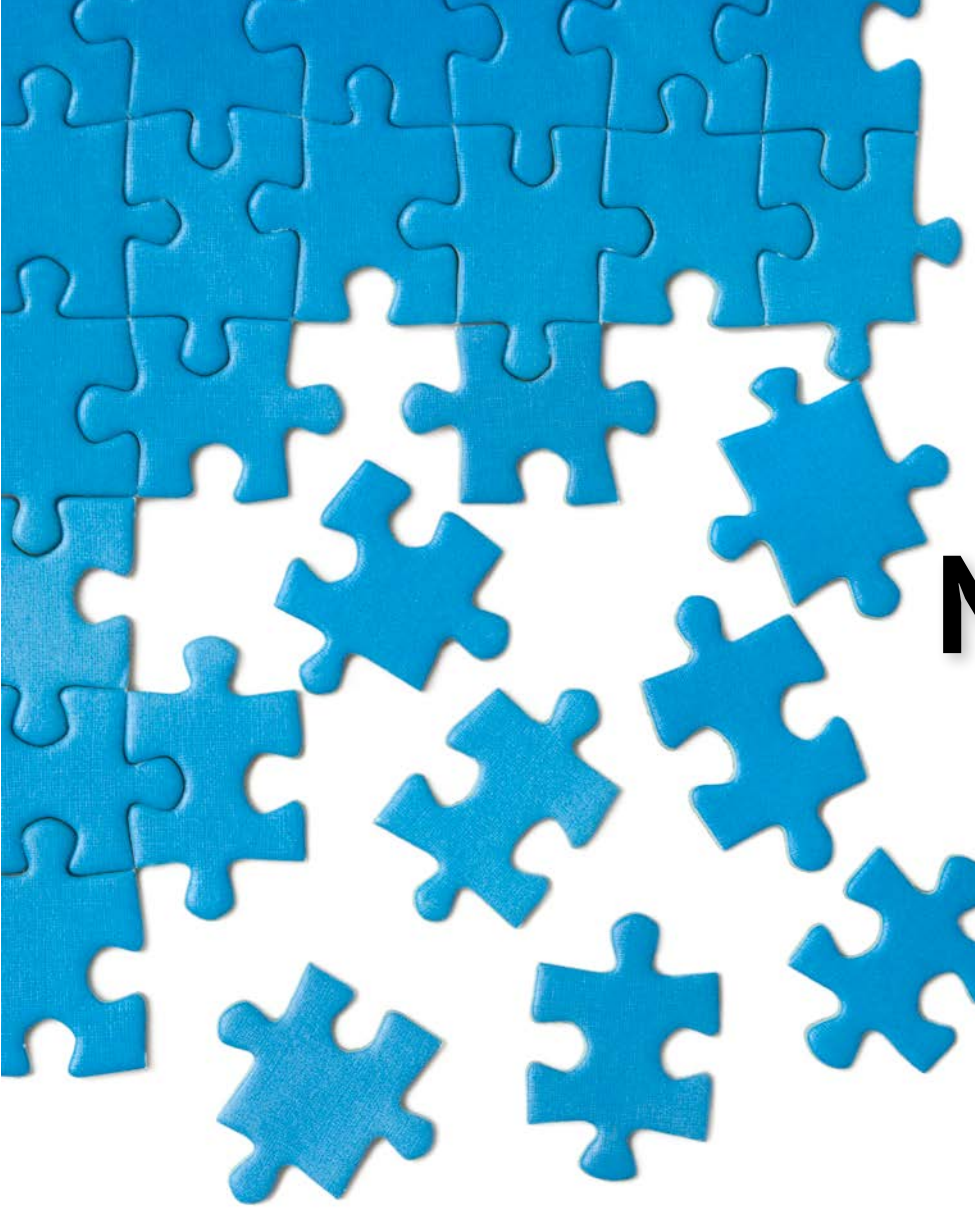

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Power Transmission Engineering

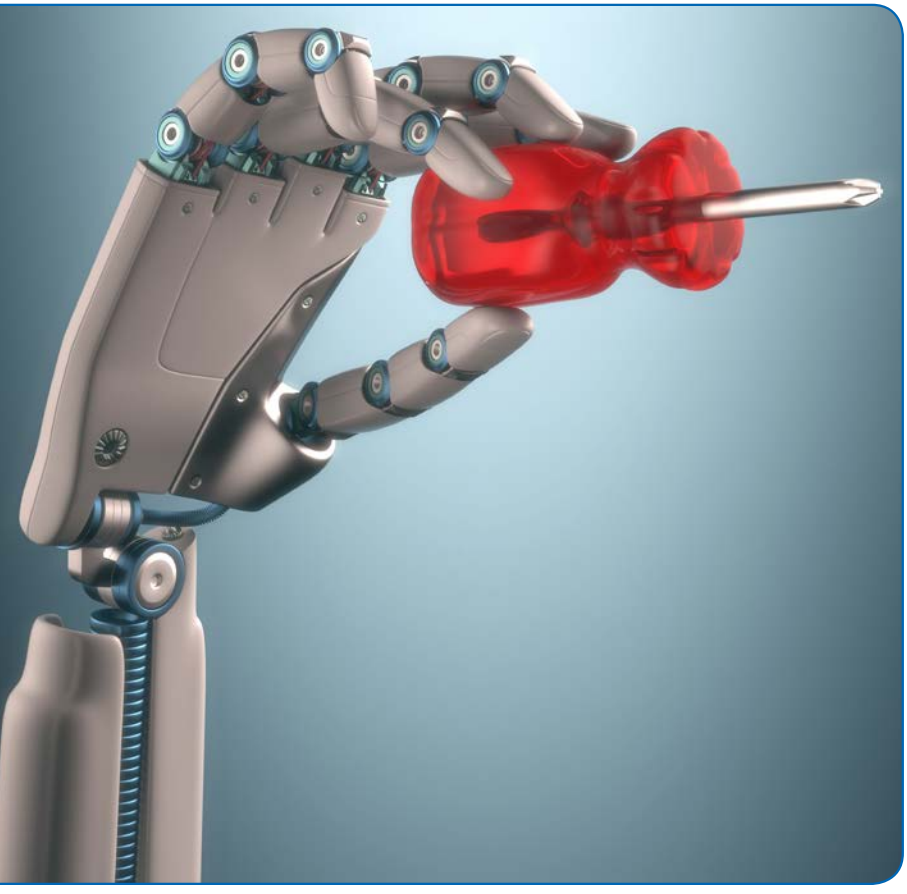
Motors and Mechatronics — Moving to a Higher Plane

Jack McGuinn, Senior Editor

Electric motors (left) from Brother Gearmotors and control systems from Dart Controls are typical of the components found in mechatronic operations. (Photos courtesy Brother Gearmotors and Dart Controls.)

This is an article about motors — preventive motor maintenance, actually. And something else — mechatronics. In today's high-tech manufacturing and industrial use environments, it is near impossible to talk about equally complex motor maintenance and repair-or-replace protocols without it. While it is generally acknowledged that Japanese company Yaskawa first coined — and utilized — mechatronics way back in 1969, what's usually missing is an explanation of why U.S. manufacturing took so long to adopt it. That's a story for another time. But motor-specific mechatronics is the focus here, which has a somewhat briefer history.

"The first International Conference on Advanced Mechatronics (ICAM) was held in Tokyo in 1988, and around that time early insulated gate bipolar transistor (IGBT) technology permitted significant reductions in cost and size of variable frequency drives (VFDs) used with electric motors," explains John Morehead, principal consultant for Motion Mechatronics LLC. "Shortly thereafter more sophisticated vector-controlled drives that modeled the motor's electrical performance inside the controller were introduced. Most methods used to monitor the condition of a motor, such as vibration analysis, required human intervention. Around the beginning of the 21st century as VFD sophistication increased along with microprocessor power some VFD electronic controls were able to use the motor as a transducer for motor condition monitoring."



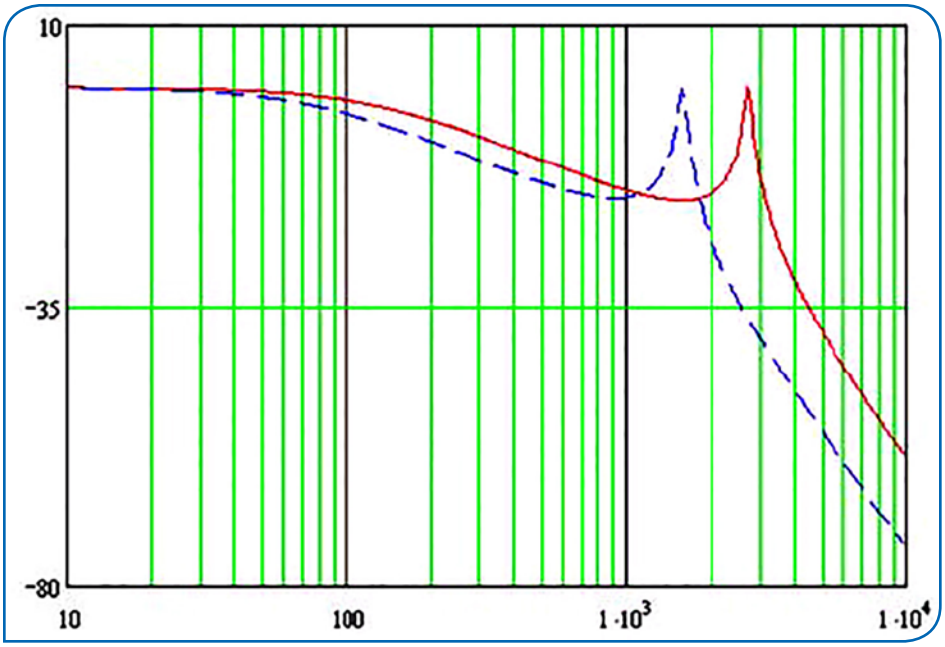
Some, like Kollmorgen manager/training and digital services, Bob White, say the history goes back further. "The discipline of considering the synergy between mechanical, electrical, and control systems has been around since the 50s."

What's more, mechatronics even offers a dash of 1950s Cold War intrigue.

"The adaptation of true mechatronics has a date well before the official release of its name," explains Lee Stephens, Kollmorgen senior systems engineer. "A book on statistical dynamics of control systems (*Introduction to the Statistical Dynamics of Automatic Control Systems* — used paperback 1960 edition available on Amazon) was published in 1952 by an author named V.V. (Vladimir Viktorovich) Solodovnikov. This was where an electronic amplifier was fed an error signal and a gimbal-mounted radar was used to track missiles. The papers were smuggled out of the old Soviet Union and were pretty advanced at that time. Interesting that this was done well before the feared Star Wars program of the U.S. in the 1980s."

How is mechatronics defined? It's a question that elicits both brief and detailed responses.

"We define mechatronics as the union of mechanical, electrical/electronic and software



Screen capture of a Bode plot — used to analyze system mechanics and control electronics (courtesy Kollmorgen).

engineering, resulting in gearmotors utilized with electronic controls and software to perform work more precisely, quickly and reliably than if it were performed using separate, discrete functions," says Juan Avalos, applications engineer for Brother Gearmotors. Adds Mark Lewis, VP marketing & sales, Dart Controls — "The integration of the most applicable facets of mechanical, electrical and computer engineering into a product or process solution, resulting in a better solution than any one of the separate disciplines can deliver."

Kollmorgen's Stephens says that "Mechatronics to me is a melding of the physical expectations of a motion system whether mechanical, electronic, hydraulic, and pneumatic or any hybrid of technologies used to accomplish a physical task. Often, these systems are trying to duplicate, simplify or assist a human function, most often a repetitive motion that a machine can do better. When combining technologies as mentioned earlier, it usually takes a team of engineers as opposed to an individual."

And here's the succinct version, provided by Holling: "The interaction and/or combination of mechanical systems with electronics and electronic motion systems."

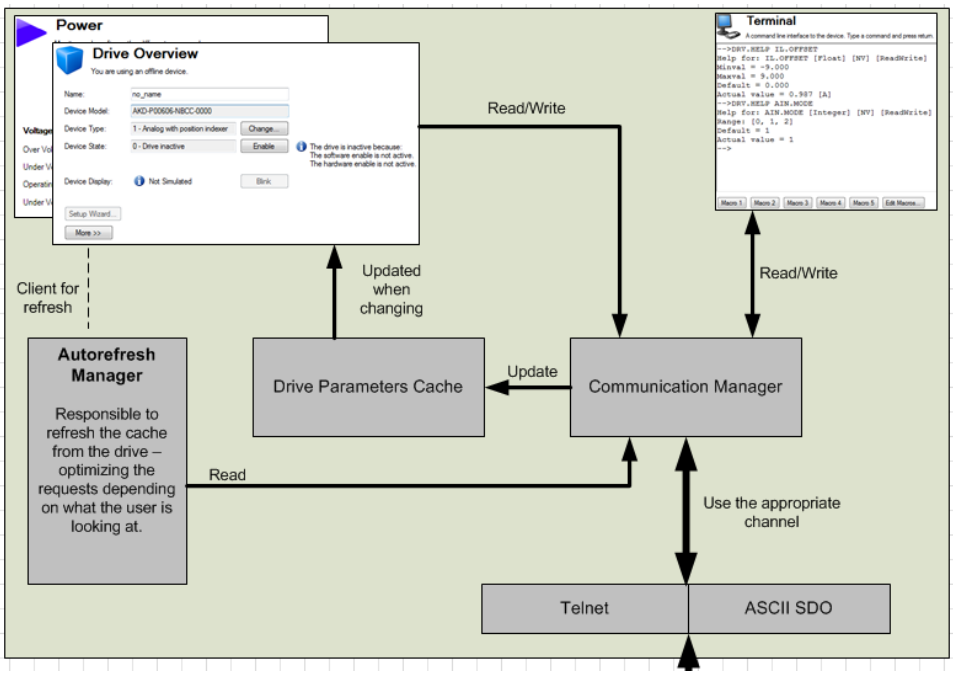
When implemented, how does mechatronics monitor motor maintenance, service life and repair-or-replace issues?

"Mechatronics generally applies more to the total system view and design, which may include service life, repair and replacement," says Holling. "Maintenance is not always addressed, although many modern controls now keep track of operating hours and issue maintenance reminders. Advanced diagnostics that can identify pending failures are the new forefront."

"(The intent of mechatronics) is to remove 'trial and error' from the process of development," explains Dan Wolke, Kollmorgen senior systems engineer. "One by-product is a complete mathematical understanding of the properties of the machine. That "understanding" would allow a much more accurate preventive maintenance schedule, i.e. — a math model that can run independently of the machine to estimate component life.

"System modeling, vibration analysis, and other analytical methods, utilizing state-of-the-art feedback sensors can collect, analyze, and predict preventative maintenance schedules. As a simple example, data collected over time on certain running currents can detect if the mechanical system is wearing excessively if the running current is trending upward above a target range," White adds.

Lewis points out that these same sensors are relied upon to "detect (motor) vibration, current draw, temperature and speed," and that "these data can be collected and transmitted via an IIoT network for analysis and preventative main-



An AKD interaction flow tracks system operation and its various elements (courtesy Kollmorgen).

tenance scheduling."

Brother's Avalos says — "(Regarding) motors, mechatronics has the possibility to project a possible motor defect or fault by monitoring current or running time. It will help enable the user to more optimally time maintenance."

One might wonder if any growing pains exist in implementing a mechatronic motor maintenance system. It depends on where you are starting from.

"As always, it is best when a system is designed for its intended use," advises Holling. "Adding electronic control and motion control to an existing system can improve its performance, but you may not always be able to compensate for a poor existing mechanical design."

And, Avalos adds, "The user needs knowledge of control. A mechanical part is not so difficult to replace, but for controlling the mechanical part, need turning/control knowledge" is needed.

Kollmorgen's White further explains that "Mechatronics is combining a variety of disciplines in designing or retrofitting a particular machine design. Any growing pains would be learning how to consider how each element of the design fits together to optimize the machine performance." Colleague Wolke cautions that "Mechanical design changes needed to achieve additional performance can sometimes be very painful to deal with after metal has already been cut."

"Most engineers graduate with a degree in either mechanical or electrical engineering," Kollmorgen's Ritchie points out. "Educational institutes teach the mechanical and control systems separately from each other, instead of a combined disciplines. The separate disciplines naturally combine in the 'real world' outside of the educational environment."

On the OEM side of things, mechatronics — and the data it provides — are an increasingly larger part of the manufacturing equation. Indeed — it is seemingly all about capturing the info.

"From a drive perspective," says Lewis, "there is a growing interest in the amount of information available from the drive relative to the motor under control; specifically — amp draw, ambient temperature, verification of motor rotation. The OEMs seem to be implementing mechatronics themselves, but need information from products like motor drives to implement their mechatronic solutions."

Avalos points out that "Mechatronics is required for the smart factory technology such as IIoT or Industry 4.0, and as a result the demand will be higher."

"Over the past 20 years," Morehead adds, "industrial and commercial equipment OEMs have widely adopted brushless motors with integral gearing, as well as integral motion controls and their supporting software as an all-in-one mechatronics solution that not only simplifies machine construction but also increases reliability and durability."

Kollmorgen's White adds that "I don't think it's a case of 'implement mechatronic practices' but understanding and implementing tools based on mechatronics. For large opportunities, we have been known to give Control Engineering math model support to customers to help in successful machine design. Most companies that supply motion control systems have been applying these principles as common practice. OEMs who desire to mix motion elements from multiple suppliers tend to have the mechatronic skills to successfully integrate."

"Integrate" is the key word here; mechatronics done right is key to intelligent manufacturing processes. The result? Peak performance up and down the line.

"(For motors), mechatronics will help to output 100% of the motor's ability to make OEM's application-to-output 100% of the application ability. This will affect size down, cost down and improvement of energy efficiency," says Brother's Avalos. To which Morehead adds: "Mechatronics' appeal to manufacturers follows two tracks: systems and economics. Mechatronic systems are more efficient, flexible, reliable and offer scalability compared to individual components. Properly designed mechatronic systems can also be more economic from an installation standpoint and their increased reliability offers not only greater machine lifetimes but also reduces potential for lost revenue as a result of machine downtime."

Given that mechatronics in some form has been around for decades, you have to wonder what comes next — is continuous improvement a given? What would the next iteration look like?

"Advance of AI technology and miniaturization of the electrical parts and cost down of these will help for the future development," says Avalos. "We're only starting to see communications in the form of Internet connectivity or real-time SMS alerts being incorporated into PLCs and other devices," Morehead states. "Fortunately for the industrial world, many

Dart brushless controls are used for system modeling and other analytics. (Courtesy Dart Controls)

developments in this field and other sensing areas are being driven by the smart phone industry; it's economic and size constraints will bring forth new tools that can be incorporated into motors, gearing and controls that would have been unimaginable a decade ago."

Rocky Mountain's Holling believes "(Mechatronics) is still an evolving process, and designers and managers are still learning to understand the global holistic view that mechatronics encompasses, and where mechanics and electronics are combined in an optimal way to deliver the highest performance in a most cost-effective way.

And for White? "Mechatronics as a discipline is becoming more prevalent at a variety of universities as discipline within engineering departments. Many technical and trade schools have embraced Mechatronics. Additional advances will come as increased computational power and sophisticated feedback sensors combine to adapt to a variety of machine conditions. Eventual connectivity to IoT will allow a machine operator to receive maintenance warnings via a smart phone and web connectivity to diagnose machine problems from remote locations.

"It is still an evolving process and designers and managers are still learning to understand the global holistic view that mechatronics encompasses: where mechanics and electronics are combined in an optimal way to deliver the highest performance in a most cost effective way." **PTE**

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IN CLOSING...

We asked the group for some closing comments relative to mechatronics and motor performance, maintenance and repair/replace.

Mark Lewis, Dart Controls

From a drive/control perspective, the IIoT concept is driving suppliers to sense and measure variables in the processes under control. Not sure where mechatronics and IIoT meet, but I believe they do. The key for both are a) solutions that deliver meaningful value-performance, savings and reliability, and b) make use where possible of existing installed base. New technology is cool, USEFUL new technology is really cool.

John Morehead, Motion Mechatronics LLC

In response to the increased deployment of motors in mechatronics systems, over the past decade post-secondary education organizations have begun to offer certifications in the expanded field of mechatronics maintenance. Their curriculum typically includes the primary branches of mechatronics: servo-controls and control theory, mechanical drives, information technology, and electronics.

Dan Wolke and Gordon Ritchie, Kollmorgen

Wolke

To me, Mechatronics is a tool used in the design of a machine or system for a target performance and life. When done properly, it results in a mathematical model of the system that can be used, not only for optimizing performance, but modeling component run life.

But the mechatronic process consumes a huge amount of engineering resources so there becomes a question of how much effort is needed? Example: When NASA designed a rocket, the cost of failure is too great so they spend a large effort into using mechatronic in their design. On the other hand, adding a simple actuator to an existing machine may only require using good known Mechatronic guidelines and not a full Engineering effort to model the performance.

Ritchie

Machine design, going forward, will develop a natural process of marrying mechanical components to control components. By doing so, machine design can take advantage of stiffer mechanical systems and higher resolution feedback. Machines will become more accurate, faster, and more reliable. **PTE**

Fluid Couplings vs VFDs for High Inertia Rotating Driven Loads

A Selection Guide Reviewing the Merits of Both Options

Ian Miller, Motion Industries Canada

As the old adage goes, "There is more than one way to skin a cat." In the early stages of any project, system designers are faced with choices; whether they are designing a new application or retrofitting an old one, they need to determine what is the most efficient, economical and practical way of completing the task at hand. Though there are usually at least two viable means to accomplish the task, the first step is always to review and weigh the merits of each option. Fully understanding these options, as well as the benefits and drawbacks of each, will invariably lead to a better, more robust design. Not weighing these possibilities can lead to project delays and budget overruns.

When it comes to high inertia, rotating driven loads, several factors should be addressed. Startup and slowdown behaviors are typically the primary concerns but attention must also be given to the behavior of the equipment while running. Applications can vary from large conveyor systems, crushers, pumps, fans or any number of equipment types. Each application will have its own operating nuances, and these will need to be considered during the design process.

For handling the startup/slowdown and operational running dynamics of a high inertia, rotating driven load, two options are commonly reviewed: fluid couplings and variable frequency drives (VFDs). Starting and stopping any high inertia load and dealing with the massive potential energies of such a system is always a challenge. If you then add the potential shock loads, resonance issues or any number of other concerns that typically accompany this style of system, you can see that particular attention must be paid to mitigating these factors. Ramp up, ramp down and dampening become of paramount importance, and controlling/protecting the prime mover is a critical design concern.

Both fluid couplings and VFDs have inherent benefits and drawbacks. Understanding these benefits/drawbacks as well as the application at hand will allow for choosing the most appropriate solution for a particular application. The following discussion of technical intuition may assist those facing these design challenges at the project's onset.

Variable Frequency Drives (VFDs)

Before discussing the merits of a VFD, let's first discuss its operation and the applications for which they are used. A VFD is an electronic device often used in place of a magnetic motor starter. Its purpose is to start/stop a motor as well as to control its speed, speed ramps, current draw and a wealth of other control features. (For the purpose of this article, when we discuss a motor it will be assumed it is in reference to an induction squirrel cage motor.)

VFDs accomplish this motor control by utilizing solid state switching to first rectify incoming power into Direct Current (DC) and then invert that to outputted power as Alternating Current (AC) at a variable frequency. With reference to speed control of a motor the equation is as follows:

$$N = \frac{120f}{p}$$

Where:
N = Synchronous Speed
f = Frequency in Hz
P = # of Poles in the Stator

When looking for variables to modify speed over a broad range in this equation, frequency immediately stands out as the best opportunity. This is where the core value of a VFD lies. By changing the frequency of the outputted current we are able to control a motor's acceleration, deceleration and velocity while also controlling current draw and overload dynamics. This ability to control current is often thought of as a secondary benefit but it should not be overlooked. The algorithms and user interfaces offered today make this a feature almost as important as the speed control depending on the application.

As applied to high inertia rotating driven loads, a VFD would be used to control the motor (prime mover) used to drive the load. When looking to mitigate the issues associated with startup, slowdown and dynamic speed control of a high inertia rotating driven load, being able to control velocity, acceleration and deceleration by varying frequency is pretty self-evident. VFDs typically utilize an observer control system that offers excellent results given the algorithms currently in use. This control can also be upgraded through the implementation of a motor speed encoder. This additional feature allows for a very robust control and has the added benefit of system monitoring for operators. As utilizing a speed feedback sensor for a high inertia rotating load application is fairly commonplace, the additional cost for implementation is often negligible.

The ability to slowly ramp up a high inertia rotating load allows for the use of a smaller prime mover and can lower the overall cost of other mechanical components within the system. Dynamic speed control of such a load is also a very useful feature and can help add to the overall versatility of a system. A good example would be the ability to control the speed of a boiler in-feed pump at a power generating station. These days it is critical for power plants to be able to dynamically react to renewable energy sources that are feeding the grid at unpredictable rates, system features like the aforementioned are needed to accomplish this. Deceleration con-

trol is another critical feature for a high inertia rotating load. If the potential energy of the system is not properly dispelled in a controlled manner, it can have grave consequences for both the system and those that operate it.

Deceleration in particular is a large concern during system design. Luckily, most VFDs now offer a feature for dynamic braking/regeneration that will allow for a motor to act as a generator during deceleration/braking period. The energy that is generated during this cycle can then either be reintroduced to the grid (offering an energy savings) or dissipated over a set of braking resistors. This feature although sometimes overlooked, can offer excellent control and the breaking power available is only limited by the physical constraints of the prime mover (i.e., the power generated by the motor during deceleration). This can be a very effective means of breaking for such applications.

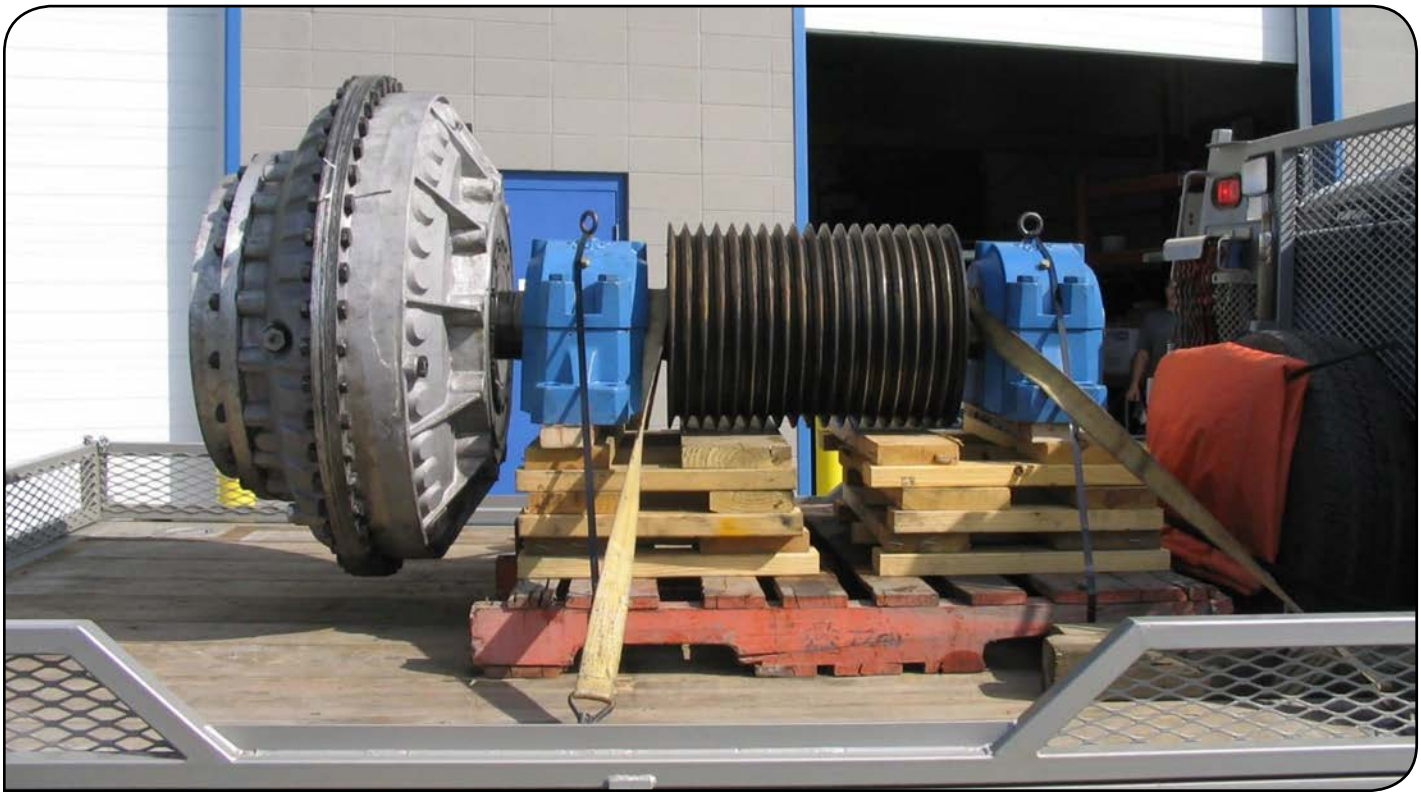
The control systems included in most VFDs today make them much more than a simple means of controlling motor speeds. Often manufacturers incorporate user programmable control systems with inputs/outputs (both digital and analog) and a wide range of communication protocols. This means that for some systems, the VFD can also be used as a standalone control platform, further reducing integration costs. The ever-growing options for communication protocols also make integration into existing control systems evermore seamless.

The evolving control platforms now offered on most VFDs make programming current control/overload dynamics much easier. This allows for advanced means of ensuring that both the equipment and power grid to which it is attached is protected. This current control will not eliminate torsional vibration or shocks transmitted from the load to the motor but it does allow for the control of how the motor reacts by means of controlling the current available. This feature can also be used to trigger alarms, limit current draw/dynamics or trip the system if the current draw of the motor exceeds a predetermined value, value over time, or even value acceleration as defined by the programmer. Such features can help prevent/reduce the instance of catastrophic failures and provide operators and maintenance staff with a better understanding of the condition of the equipment. Current draw can also be trended and used to provide operating baselines under different operating conditions, another tool that can be used to determine/evaluate equipment life/condition.

Fluid Couplings

Fluid couplings are mechanical couplings that are filled with a fluid, typically oil. A common example and one that most people would recognize is a torque converter in any vehicle with an automatic transmission. The fluid coupling (or torque converter as it is commonly known) is used to couple the prime mover (the engine, typically gas or diesel driven) to the transmission of the vehicle. The fluid coupling is what enables an automatic transmission vehicle to be at rest while the engine is running and also controls the dynamics of starting and stopping the drivetrain of the vehicle. As anyone who has ever stopped at a red light while driving such a vehicle knows, this is a very convenient feature. When stopped at the light, the engine is still turning at idle speed but the coupling is allowing for 100% slip, thus keeping the engine from stalling and the vehicle from moving.

A fluid coupling is able to accomplish this feat by way of



Refurbished crusher drive assembly for a coal fired power plant. Photo courtesy of Motion Industries (Canada) Inc. service center in Edmonton, AB.

both a simple and eloquent design and construction. In its most basic form, it can be thought of as two coupling halves or bladed wheels enclosed by a housing. These two halves are not mechanically linked but are submerged inside the same body of fluid. As the drive side begins to turn, it is free to move independent of the driven side. As the speed increases, gradually energy is transmitted via hydro dynamic forces from the drive side to the driven side.

The amount of energy that is transmitted (i.e., the level of slip) is highly dependent on the level of fluid within the coupling and the speed at which the drive side is turning. Starting, stopping and running dynamics of a system can be modified/customized by varying the level within the coupling housing. Furthermore, level control is a feature that can be dynamically controlled through the addition of an external hydraulic circuit. This can allow for on-the-fly adjustments by a control system or operator. When referencing these two types of couplings, they are typically defined as either "fixed level" or "variable level" couplings.

As applied to high inertia rotating driven loads, fluid couplings are typically mounted between the prime mover and the driven load. Unlike a VFD, whose use is limited to electrical motors, a fluid coupling can be used in a far broader fashion. But like a VFD, a fluid coupling is typically implemented when looking to mitigate the issues associated with startup, slowdown and dynamic speed control of a high inertia rotating driven load**.**

For applications where dynamically varying the operating speed is less important than controlling start up, slow down, drive train isolation or load sharing dynamics of a given system a fluid coupling is a good fit. The bulk of applications utilize a fixed level but variable level couplings do exist and are not that uncommon. The cost associated with the design and manufacturing of this style of coupling can be cost prohibitive. When selecting a variable level coupling a lot of time is needed to work collaboratively with the manufacture to ensure that the right design is selected prior to manufacturing.

For applications utilizing the fixed displacement style of coupling, attention must be paid during the design and commissioning stages to ensure that the appropriate fluid volume is determined to match the application. This is a critical step in the design process as it will have the greatest effect on system operation. This level will also determine the speed at which the driven load will operate.

One of the greatest benefits of a fluid coupling is its ability to dampen torsional vibration and shocks transmitted from the load to the prime mover, thus extending equipment life. Slip within the coupling can reach one hundred percent during extreme events, often preventing catastrophic failure. Load balancing for multiple drive applications is also possible by adjusting individual fluid levels and can help to greatly reduce project costs by driving a load from multiple smaller prime movers.

Summary

The advent and advancement in recent years of both fluid coupling and VFD design have made system design of high inertia rotating driven loads much easier. These advancements have allowed designers to tackle application challenges and to build more robust equipment for industry. As these products continue to advance, particular care needs to be given to fully understanding all of their features and how they can be applied to tackle design challenges. Determining what is the most efficient, economical, and practical product for your given application is the key to good system design.

When it comes to determining if you will select a VFD or fluid coupling for your particular application there are many things to consider. Both options have similar advantages but also offer some unique features. Facilitating speed ramps/running dynamics and load sharing are shared features.

The unique feature for a VFD is its ability to control current to the prime mover. It has the ability to fully control current, thus enabling the system to eliminating current spikes, control and react to overloads and also reroute power from the motor enabling for a form of dynamic breaking. Past that, a VFD offers great system/control flexibility. Features such as over speeding a motor by raising the frequency past 60 Hz and its ability to be used as a control platform for small standalone applications can greatly reduce capital costs and provide system flexibility during start-up and commissioning.

A fluid coupling's differentiating features mostly have to do with its ability to dampen torsional vibration and shocks transmitted from the load to the prime mover. This is ideal for applications like crushers, where issues of erratic loading and unloading of the system exists as does the possibility of jamming.

Never before has there been a time where so many products of such advanced design have been available for implantation. Continued diligence by system designers to stay current with these technologies is needed to ensure that full advantage can be taken on the behalf of end users of these great advancements. **PTE**

Ian Miller E.I.T. is Branch Manager of Motion Canada's Calgary Service Center and Alberta- based Tech Group. He has over a decade of hydraulic and electrical experience in the field including system design, troubleshooting, on-site installations, and technical training/support. To find out more, visit *www.MotionIndustries.com*, or *www.MiHow2.com* for short, instructional videos on hydraulics and many other topics.

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Eats, Drinks and Treats

Process Expo and Pack Expo Highlight the Latest Technology for Food & Beverage Applications

Matthew Jaster, Senior Editor

Industrial applications for the food and beverage industry require certain parameters. They must be efficient, reliable, robust and most importantly clean. Components in this industry have to meet the challenges of the harshest environments in order to maintain strict global regulations and standards. *PTE* has assembled a preview of some of the products featured at Process Expo (Chicago, Illinois) and Pack Expo (Las Vegas) that will interest anyone involved in these system-critical areas.

Process Expo 2017

Process Expo represents the pinnacle of food technology bringing together the world's most successful food and beverage processors, equipment manufacturers and leaders in the field of academia. It is owned and organized by the Food Processing Suppliers Association (FPSA), a global trade association serving suppliers in the food and beverage industries. Nearly 600 food processing and packaging exhibitors will display machines, products and services specific to food and beverage processing. Here are some of the Booth's you should stop by at McCormick Place in Chicago from September 19–22:

Baldor

Booth 673 (North Hall)

It's essential that your food processing operation runs efficiently, with full attention to food safety. Every process is critical to a facilities success, and it's imperative that the safest products are specified for the intended application, not only for the safety of the food, but for the life of the driven equipment.

Baldor-Reliance motors and Dodge mechanical power transmission products are designed around food industry sanitation standards with smooth rounded surface textures, minimal crevices and proper sealing for ultimate reliability in environments subject to direct contact with food. Food safe products also undergo stringent testing to carry IP69K for water ingress protection rating for the high pressure, high temperature cleaning methods.

Stop by Baldor Electric Companies Booth (#673) at Process Expo and meet with industry experts to learn more about specifying the correct products for different zone environments. (*www.baldor.com*)

Baumer Sensors

Booth 2834 (North Hall)

With its wide range of reliable stainless steel sensors in a robust washdown or hygienic design, Baumer offers a unique product portfolio for the food and beverage industry. The sensors meet the highest standards concerning detection reliability, durability, leak tightness and reliability, even in demanding environments. The sensors as well as the extensive accessories are compliant with the required standards and regulations, e.g. Ecolab, FDA and EHEDG.

Features include: innovative flow, pressure, temperature, level and conductivity measurements in industrial process engineering, precise measuring tasks down to the micrometer range, efficient position detection of objects with different sensor principles (photoelectric, ultrasonic, inductive, capacitive), image-based identification and object recognition with smart vision sensors and cameras and reliable encoders for motion control tasks. (*www.baumer.com*)

Brother International Corp.

Booth 4302 (North Hall)

The new IE3 premium efficiency gearmotors offer increased efficiency over standard IE1 models throughout the speed range and initiate less mechanical stress, which directly translates into long-term energy savings. The IE3 gearmotors run cooler and with less noise and, as they are sealed for life and require practically no maintenance, reduce costly downtime. Two factors in the enhanced durability of Brother's IE3 gearmotors are the company's ultra-long-lasting e-coat paint and lubrication through premium H1 food-grade grease.

Additionally, Brother offers subfractional AC gearmotors and reducers for the food and beverage, packaging and material handling industries. The company expanded its mid-series product line with the addition of the G3, H2 and F3 series of fine-pitch gearmotors with ⅛ to 3 horsepower capabilities at its U.S. manufacturing facility in Tennessee.

The models showcase Brother Gearmotors' standards for smaller, lighter, reliable and efficient power transmission components. Each features hypoid or helical gearing, which leads to greater torque output and allows for smaller motors to aid in energy efficiency.

(*www.brother-usa.com/gearmotors*)

Cone Drive

Booth 3810 (North Hall)

Cone Drive's Series B reducers provide an economical, flexible, and compact solution to fulfill the low-to-medium power range requirements. With capabilities up to 20 hp and output torque up to of 5,000 lb in. in a single stage, Series B can provide design flexibility with lasting performance.

The Accudrive Series RG is a compact right angle precision drive providing an economical solution for your general automation applications. Built around the Cone Drive double-enveloping worm technology, the Accudrive Series RG is available in standard and low backlash options.

The Accudrive Stainless Servo precision motion drives are designed for sterile manufacturing environments. The product's smooth surface and curved contour allows for easy cleaning and bacteria-free surfaces, perfect for food processing and pharmaceutical applications. The product is designed and rated to IP69k providing maximum protection against contaminant ingress as well as leak free operation.

Accudrive Series P high precision inline planetary servo drive will satisfy your most demanding automation applications. The compact design, universal housing with precision bearings and precision planetary gearing provides high torque density while offering high positioning performance. (*www.conedrive.com*)

Garlock Sealing Technologies

Booth 1673 (North Hall)

Garlock is a multinational manufacturer of high-performance fluid sealing and pipeline solutions with an emphasis on safety, longevity, and productivity. The company works in partnership with its customers, industry associations, and governmental entities to understand their unique sealing challenges and respond with innovative solutions that keep people safe while increasing profitability.

Garlock sealing solutions protect millions of people every day from exposure to life-threatening materials. Durability, ease of maintenance and other benefits are essential to the value of using a Garlock sealing solution, but without safety, none of those other factors would matter.

For more than a century, the Garlock family of companies has been helping customers across the globe efficiently seal the toughest process fluids in the most critical applications. They are presenting their portfolio of premium sealing solutions for challenging applications in the food industry. Garlock designs and manufactures a comprehensive range of solutions for a multitude of processes.

(*www.garlock.com/en/*)

Stober Drives, Inc.

Booth 2637 (North Hall)

The quality-proven, high-efficiency MGS "K" Series speed reducer is available in a stainless steel housing as the "KSS" Series. The adaptability of the double-side, wobble-free, stainless steel bushing system (with expanded bore sizes) makes this unit ideal for the harshest washdown application.

The "PSS" is machined from 16-2 stainless steel bar stock and is capable of handling output torques up to 3,894 in. lbs. Using this planetary reducer ensures exact alignment and minimal wear.

Through constant innovation and development, Stober has become known for high performance, high efficiency, and low noise throughout its various gearing solutions for industrial applications. Visit the website for additional products and services.

(www.stober.com)

Process Expo 2017
September 19–22
Chicago, IL
www.myprocessexpo.com

Pack Expo 2017

Pack Expo Las Vegas, North America's largest packaging event of 2017, will bring together the solutions needed to launch new products and solve production issues. Corporate managers, engineers, sales managers, plant managers, manufacturers and production supervisors, brand and marketing managers, quality controllers, purchasers, research/development and package designers from a wide variety of consumer packaged goods companies (CPGs) will be in attendance. More than 2,000 exhibitors will display state-of-the-art technologies, equipment and materials. The show is co-located with the Healthcare Packaging Expo, bringing pharma/biopharma, nutraceutical and medical device manufacturers together for the latest trends, innovations and solutions. (September 25–27)

Baldor

Booth 5242 (Central Hall)

Now more than ever, it is vital that food and beverage & pharmaceutical companies choose supplier partners that understand their processes and offer a full range of solutions. Stop by the ABB Booth (#N-5242) to see the latest product innovations for the industry. In the booth attendees will find a completely operational packaging line integrated with a full portfolio of products offered across ABB business units.

On display will be Baldor-Reliance motors along with Dodge mechanical power transmission products designed for multi-shift food and pharmaceutical processing applications. The comprehensive portfolio aims to minimize energy costs while providing reliability in some of the toughest environments.

Baldor-Reliance stainless motors and Dodge Ultra Kleen gear reducers carry IP69K for water rating to ensure reliability in high pressure and high temperature washdown environments.

ABB HDS servomotors are designed at high pole counts to provide more torque and less cogging for greater positioning accuracy, speed and efficiency.

Stop by the Booth (#N-5242) and talk with ABB industry experts to solve your specific application challenges. (*www.baldor.com*)

Emerson

Booth 5222A (Central Hall)

Emerson's Numatics 500 Series Zoned Safety Manifold with G3 fieldbus electronics offers an effective alternative to redundant safety dump valves to meet the Machine Safety requirements of the Machinery Directive and ISO 13849-1. The manifold system has the ability to control multiple and independent groups of pneumatic valves that operate a section of a machine, disabling air and power only to the components in the zones that control equipment that will come in contact with the operator. This ensures operator safety and allows the rest of the machine to remain in operation when these safety circuits are enabled.

Packaging lines without the ability to effectively seal various container sizes and complexities experience more rejects and recalls, raising operating expenses and damages reputation. Emerson's Branson DCX-F is a compact ultrasonic welding power supply that achieves consistent weld quality through continuous system monitoring and closed-loop process control. The DCX-F features five weld modes controlled by a PLC over a Fieldbus network for enhanced automation control. The DCX-F's real-time feedback of weld-quality indicators and accurate output amplitude result in greater weld consistency and fewer rejects regardless of package complexity.

Emerson's SolaHD SDU-A Series DIN Rail AC UPS System with optional communications card is an uninterruptible power supply that helps operators stay safe by delivering protection from damaging impulses and power interruptions to microprocessor-based devices. During a power disturbance, the technology provides immediate back-up AC for up to four minutes so that processes can continue or be intelligently shut down without causing unsafe conditions. The unit also enables operators to safely control the power restart without untimely accidental circuit re-energization. UPS status updates while the SDU-A is running helps operators prevent equipment hazards. (*www.emerson.com*)

J.W. Winco

Booth 6060 (South Lower)

J.W. Winco, Inc. offers stainless steel parts for industries with very high corrosion resistance, hygienic properties, and the ultimate in material quality.

When you need to align, hold, or latch different parts of equipment together, you need a spring loaded device. These components use the force in the spring to apply pressure so that the ball or nose will remain nested in some sort of hole or other receptacle. Thus two or more elements of equipment can be aligned or fixed into a determined relative position. Indexing plungers have a beveled or rounded nose that inserts easily into an indexing receptacle. Our indexing plungers include features like cam action, lock-out or non lock-out types, threaded bodies, weldable mounting flanges, long knobs, plate mounts, ring or L-handles, and more.

Adjustable levers are clamping components that offer a ratcheting feature that is especially useful in tight spaces. Their design also allows for easier visual adjustment to specific positions, and their ergonomic shape makes them user-friendly. They are ideal for situations where more torque is required than can be achieved with a simple knob. (*www.jwwinco.com*)

Neugart USA Corp.

Booth 5841 (South Lower)

Neugart's Hygienic Design Gearbox (HLAE Series) offers functionality as well as residue-free cleaning of your food processing plant – whether you are producing, handling, dosing, cutting, positioning, or packaging food. The units of the HLAE series reliably drive your processes and are designed for fast and thorough cleaning at the end of the workday. Applications include filling plant/dosing feeder, slicer, belt drives satisfying all hygienic requirements and all apps using CIP (Cleaning in Place).

For when cleaning the machine is the most basic requirement for the end customer. Dirt residues, contaminated with germs or bacteria, tend to accumulate at edges, in corners, and in pockets. The geometry of their gearboxes is certified for optimum cleaning properties and maximum hygiene.

(*www.neugartusa.com*)

Regal Beloit Corporation

Booth S-8022 (South Upper)

Regal offers a full line of power transmission equipment and mounted bearings for complete integrated solutions: unit material handling applications specifically focused on the food and beverage industry. Regal has emerged as a leader in the growing craft brewery industry as craft brewers grow and need to automate their production. Brands such as System Plast modular plastic belts and conveying components, Hub City speed reducers, Grove Gear worm gear and helical speed reducers, LEESON motors and SealMaster mounted bearings have provided compelling value propositions for craft brewers.

System Plast modular plastic belts with NG Evo components combined with NOLU S guides have allowed brewers to run dry in applications where conveying systems typically have used soap and water lubrication. NG Evo components significantly expands options for dry conveying to meet sustainability and water conservation goals which have resonated with craft brewers such as Sierra Nevada, New Belgium and MadTree Brewing, to name a few. NG Evo chain also reduces the costs and energy for water reclamation and treatment, and eliminates the wear paste buildup caused by mineral oil-based dry lubricants.

The companion System Plast Nolu-S wear strips and guides enable reduced-lubrication or lubrication-free, high-speed conveyor operation. They are made of a unique resin with a solid lubricant that dramatically reduces the coefficient of friction. Nolu-S wear strips helps reduce noise, energy consumption, squeaking and chain pull/belt fatigue. The combination of NG Evo chain and Nolu-S wear strips can reduce a conveyor's energy requirements by up to 30 percent, with a service life as much as five times greater.

The Hub City HERA (High-Efficiency Right Angle) speed reducer provides additional value in energy and space savings over the traditional worm gear speed reducers often used in these conveying applications. The HERA speed reducer comes in cast iron, epoxy coated and stainless steel corrosion-resistant units packaged with LEESON premium efficient stainless motors, leading to significant efficiency level improvements over traditional drive packages.

HERA reducers deliver 90 percent efficiency in all ratios with up to a 40 percent reduction in energy. Torque-dense with double the capacity of worm drives, HERA drives reduce motor size requirements, as well as the physical size of the drive package. HERA reducers save up to $550 per year with each increment of motor horsepower for rapid payback, and they are warranted for three years.

Grove Gear is a market-leading brand of enclosed speed reducers with one of the broadest lines of stainless steel worm gear reducers available for the food and beverage industry. Stainless Steel Center distances are offered with rapid delivery from 1.33" through 3.250", with six sizes available and ratios from 5:1 to 3600:1.

SealMaster PN Gold Mounted Ball Bearings have been used extensively in these applications. They meet both CIP (Clean in Place) and SIP (Steam in Place) sanitation requirements. High-performance, triple-lip contact seals provide multidirectional sealing to help exclude contaminants and retain lubrication. (*regalbeloit.com*) **PTE**

Pack Expo 2017
September 25-27
Las Vegas, NV
www.packexpolasvegas.com

Baldor Motor Basics: Electric Motors and Power Systems and Electric Motors and Voltage

Edward Cowern, P.E.

Motors and Power Systems

There seems to be a lot of confusion about the voltage standards for motors and why they are structured the way they are. There are, of course, two broad categories of motors, AC and DC. The voltage standards for these two decidedly different motors are much different from each other. It will be the goal of this paper to try to reduce some of the confusion that exists in the AC motor voltage standards.

AC power systems. To understand how voltage standards for motors are set it is important to know the basics of the power systems they operate on. In general, utilities that supply power in the USA, and most other 60 cycle countries, are required to provide power to the incoming point of a facility in multiples of 120 volts. Thus incoming equipment, such as circuit breaker panels, are rated in multiples of 120 volts. The common voltages are 120, 240, 480, and 600.

In addition, utilities are obligated by the regional governing authorities (usually called Public Utility Commissions) to regulate the voltage within a fairly narrow range such as plus-or-minus %.

For example, in most single-phase residential systems the voltage is 120/240. It is brought to the building with 3 wires, one being a neutral and the other two having voltages 120 volts different from the neutral wire. The voltage difference between the two "hot" wires is 240 volts.

In 3-phase systems the situation is a bit different. There are 3-phase, 3-wire, ungrounded systems where the voltage between the three wires is 240 volts. The big brother of that system is the ungrounded 3-phase, 3-wire 480-volt system. Ungrounded systems are usually found in older facilities.

In newer installations the two most popular systems are called 4-wire "grounded wye" systems. The low-voltage version is represented by a 120/208-volt system. The higher-voltage version is a 277/480-volt system. On both of these grounded wye systems, the low-voltage portion (120 or 277 volts) is only available as single-phase. The high-voltage (208 or 480 volts) is available as either single-phase or 3-phase. It should be noted that in the 4-wire grounded wye systems the high-voltage is 1.73 times (the square root of 3) higher than the low voltage. These grounded wye systems are generally felt to be safer and more flexible than the older ungrounded systems. The flexibility comes from the ability to handle single-phase lighting circuits that operate at 120 volts or 277 volts, from the same system that feeds the 3-phase circuits for motors, equipment for heating, air conditioning, elevators, and industrial machinery.

Motors. Now to discuss motors that operate on these 60-cycle power systems. In the case of "utilization equipment," such as motors, the voltage standards have been selected in multiples of 115 volts; for example, 115, 230, 460 and 575 volts. The standards for the "utilization equipment" have been deliberately picked to be slightly less than the utility delivery voltages because in an industrial plant, or large

Table 1 Summarizes this information to show the power system voltage and description along with the motor voltage rating for single- and 3-phase 60-Hertz motors

Supply Voltage	Commercial And Industrial System Configuration*	Typical 60 Hz Power System Voltages Utilization Equipment Voltage Ratings		Classification
		Single Phase	3 Phase	
120/208	3 Phase 4 Wire Grounded Wye (A)	115 208 - 230	200 208 - 230	Low Voltage
240	3 Phase 3 Wire Delta Connected (B) (Normally Ungrounded) (1)	230 208 - 230	230 208 - 230	
120/240/240	3 Phase 4 Wire Tapped Delta (C) Neutral Grounded	115 230 208 - 230	230 208 - 230	
277/480	3 Phase 4 Wire Grounded Wye (A)	277 265 (2)	460	
480	3 Phase 3 Wire Delta Connected (B) (Normally Ungrounded) (1)	460	460	
600	3 Phase 3 Wire Delta Connected (B) (Normally Ungrounded) (1)	575	575	
2400	3 Phase 3 Wire Delta Connected (B)	2300	2300 2300/4160	Medium Voltage
4160	3 Phase 4 Wire Grounded Wye (A)	2300 4000 4160	4000 2300/4160	

(1) On some systems grounding of one leg may be utilized.
(2) Some Single Phase equipment may be rated for 265 Volts.

commercial building, there may be several hundred feet between the incoming service point and the equipment. The distances involved will always lead to some voltage loss (or drop) through the wiring. On short runs this loss might be very small, even less than a volt, but on long heavily loaded runs it might be as much as 3 or 4% of the operating voltage. So choosing the utilization voltage to be different — and less than — the utility service voltage makes good sense.

There is also another factor that should be mentioned. The design standards for utilization equipment are set so the equipment is able to handle a voltage variation of plus or minus 10% of the nameplate rating. Thus a motor nameplated at 460 volts should be able to be operate successfully up to 460 plus 10% (506 volts) and down to 460 minus 10% (414 volts). If everything is right with the voltage of the system being in multiples of 120 plus or minus 5%, and the equipment voltage being multiples of 115, plus or minus 10%, then everything fits together like a neat jigsaw puzzle.

There is one oddity in the mix. That is 3-phase motors for the 120/208-volt power systems. For example, if the power system were to be 208 volts minus 5% (approximately 198 volts), and you were using a 230-volt motor, then the 230-volt motor could only go down to 207 volts (–10%) without being in trouble. There would be a discrepancy between the 198-volt low range of the system voltage and the 207 lowest operating voltage of a 230-volt motor; this could spell trouble. So — how to address it?

There are two ways that motor manufacturers have faced up to the problem. The first is to provide motors rated for 200 volts that can operate successfully down to 180 volts, or up to 220 volts. This is an adequate margin to cover the normal range of voltages that could be expected on a 120/208-volt system. But using this approach exclusively would mean that the complete inventory of motors in all sizes, enclosures, mechanical configurations, etc. would have to be duplicated to handle the motor requirements for the 120/208-volt power systems. This would be very expensive and cumbersome — especially with the wide variety of small motors (under 10 HP) that exist.

Most motor manufacturers have therefore taken a different approach to handling these smaller motors. This approach entails using a somewhat more conservative design on the 230-volt motors, by which it is possible to create a 3-phase, tri-voltage motor with voltage ratings of 208-230/460. With this approach the 230-volt winding (and connection diagram) is used on the 208-volt power system. When this approach is taken, the motor manufacturer is essentially saying that this motor can be successfully operated on voltages as low as 208 minus 10% or 187 volts. This approach usually works very well since 208-volt power systems are normally used in small buildings with relatively short distances between the incoming power service and the utilization equipment. These short runs tend to make 208-volt power systems quite stable so that the limit of the motor's low-voltage capability is seldom tested.

On motors larger than 10 HP the 200-volt motor is generally the best choice; but in many situations 230-volt motors are frequently and successfully applied on the 208-volt systems. In some cases a derate table is provided for the "low-voltage" situation. In other cases the motor service factor may be reduced from 1.15 down to 1.0 when it is applied to a 208-volt power system. Table 1 summarizes this information to show the power system voltage and description along with the motor voltage rating for single and 3-phase 60 Hertz motors.

50-hertz power systems. There seems to be an endless array of possible combinations, but most of them do make sense. In 50-hertz areas virtually all power systems are of the 4-wire, grounded wye type. A typical arrangement would be a 220/380-volt power system. In this case, as in the case of a 120/208-volt 60-hertz system, the (low voltage) 220-volt power is only available as single-phase and the 380-volt power is available as either single- or three-phase.

As a result of the voltage being described as 220/380, we frequently see specifications indicating that 3-phase motors be wound for 220/380. Although feasible to do this, it is unnecessary because the 3-phase motors will only be operated on 380-volt, 3-phase power.

Some of the most popular voltages are 220/380 and 240/415. Recently, European countries have recognized the problem of trying to provide equipment for these two different voltage standards and have come up with a standard that splits the difference. The new standard is 230/400. What this means is that if the motor has an adequate amount of tolerance, it can run on either a 380-volt system or a 415-volt system without being damaged. Also in most 50-hertz systems — unlike the domestic systems — the equipment voltage rating tends to be the same as the supply voltage. In other words, 380-volt motors are used on 380-volt systems — as opposed to situations in this country where the equipment utilization voltage is deliberately set lower than the supply voltage. Table 2 shows some typical supply voltages and the appropriate equipment standards for 50 cycle power systems.

Table 2 Typical supply voltages and the appropriate equipment standards for 50-cycle power systems

	Typical 50 Hz Commercial and Industrial Power		System Voltages	
Supply Voltage	System Configuration*		Utilization Equipment Voltage Ratings	
			Single Phase	3 Phase
115/200	3 Phase Grounded Wye	4 Wire (A)	115 200	200
127/220	3 Phase Grounded Wye	4 Wire (A)	127 220	220
220/380	3 Phase Grounded Wye	4 Wire (A)	220 380	380 400 (1)
230/400	3 Phase Grounded Wye	4 Wire (A)	230 400	400
240/415	3 Phase Grounded Wye	4 Wire (A)	240 415	415 400 (1)
250/440	3 Phase Grounded Wye	4 Wire	250 440	440
220	3 Phase Delta Connected	3 Wire	220	220
440	3 Phase Delta Connected	3 Wire (B)	440	440

(1) Alternate Rating

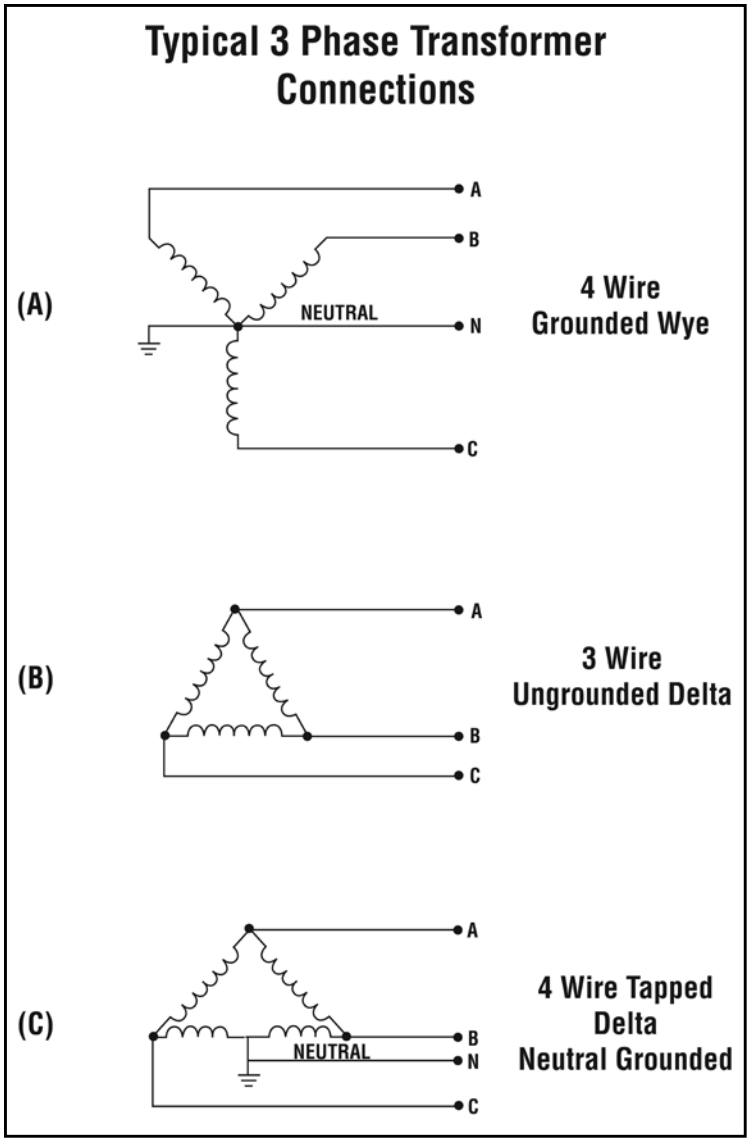


Figure 1 Typical 3-phase transformer connections.

When dealing with foreign voltage requirements, it is always desirable to check the specified voltage against the listing of available voltages indicated in a U. S. Department of Commerce booklet, *Electric Current Abroad*. If the specified voltage and frequency do not match the voltages shown in the booklet for the country and city involved, it should be a red flag that would suggest that the customer be contacted and the voltage confirmed for accuracy. Mistakes can be very costly!!

Summary

Matching motors to the power system voltages can be fairly simple if the basics of the system are understood. See Figure 1 for typical transformer connections.

Electric Motors and Voltage

The effect of low voltage on electric motors is pretty widely known and understood, but the effect of high voltage on motors is frequently misunderstood. This presentation will try to describe the effects of both low and high voltage, and to describe the related performance changes that can be expected when voltages other than nameplate voltages are utilized.

Low voltage. When electric motors are subjected to voltages below the nameplate rating, some of the characteristics will change slightly and others will change more dramatically. A basic point: to drive a fixed mechanical load connected to the shaft, a motor must draw a fixed amount of power from the power line. The amount of power the motor draws is roughly related to the voltage times current (amps). Thus when voltage gets low, the current must get higher to provide the same amount of power. The fact that current gets higher is not alarming unless it exceeds the nameplate current rating of the motor. When amps go above the nameplate rating it is safe to assume that the buildup of heat within the motor will become damaging if it is left unchecked. If a motor is lightly loaded and the voltage drops, the current will increase in roughly the same proportion that the voltage decreases.

For example, a 10% voltage decrease would cause a 10% amperage increase. This would not be damaging if the motor current stays below the nameplate value. However, if a motor is heavily loaded and a voltage reduction occurs, the current would go up from a fairly high value to a new value which might be in excess of the full load rated amps. This could be damaging. It can be safely said that low voltage in itself is not a problem — unless the motor amperage is pushed beyond the nameplate rating.

Aside from the possibility of over-temperature and shortened life created by low voltage, some other important items need to be understood. The first is that the starting torque, pull-up torque and pull-out torque of induction motors all change based on the applied voltage squared. Thus a 10% reduction from nameplate voltage (100% to 90%, 230 volts to 207 volts) would reduce the starting torque, pull-up torque, and pull-out torque by a factor of .9 × .9. The resulting values would be 81% of the full voltage values. At 80% voltage the result would be .8 × .8, or a value of 64% of the full voltage value.

In this case it is easy to see why it would be difficult to start "hard-to-start" loads if the voltage happens to be low. Similarly, the motor's pull-out torque would be much lower than it would be under normal voltage conditions.

To summarize the situation, low voltage can cause high currents and overheating which will subsequently shorten motor life. Low voltage can also reduce the motor's ability to get started and its values of pull-up and pull-out torque. On lightly loaded motors with easy-to-start loads, reducing the voltage will not have any appreciable effect except that it might help reduce the light-load losses and improve efficiency under this condition. This is the principle that is used in the so-called Nola devices that have been sold as efficiency-improving, add-on equipment to motors.

Effects of high voltage. One thing that people assume is, since low voltage increases the amperage draw on motors, then by the same reasoning, high voltage would tend to reduce the amperage draw and heating of the motor. This is not the case. High voltage on a motor tends to push the mag-

netic portion of the motor into saturation. This causes the motor to draw excessive current in an effort to magnetize the iron beyond the point to which it can easily be magnetized. This generally means that the motors will tolerate a certain change in voltage above the design voltage, but extremes above the designed voltage will cause the amperage to go up with a corresponding increase in heating and a shortening of motor life. For example, older motors were rated at 220/440 and had a tolerance band of plus/minus 10%. Thus the voltage range that they can tolerate on the high-voltage connections would be 396 to 484. Even though this is the so-called tolerance band, the best performance would occur at the rated voltage. The extreme ends, either high or low, would be putting unnecessary stress on the motor.

Generally speaking, these tolerance bands are in existence not to set a standard that can be used all the time but rather to set a range that can be used to accommodate the normal hour-to-hour swings in plant voltage. Operation on a continuous basis at either the high extreme or the low extreme will shorten the life of the motor.

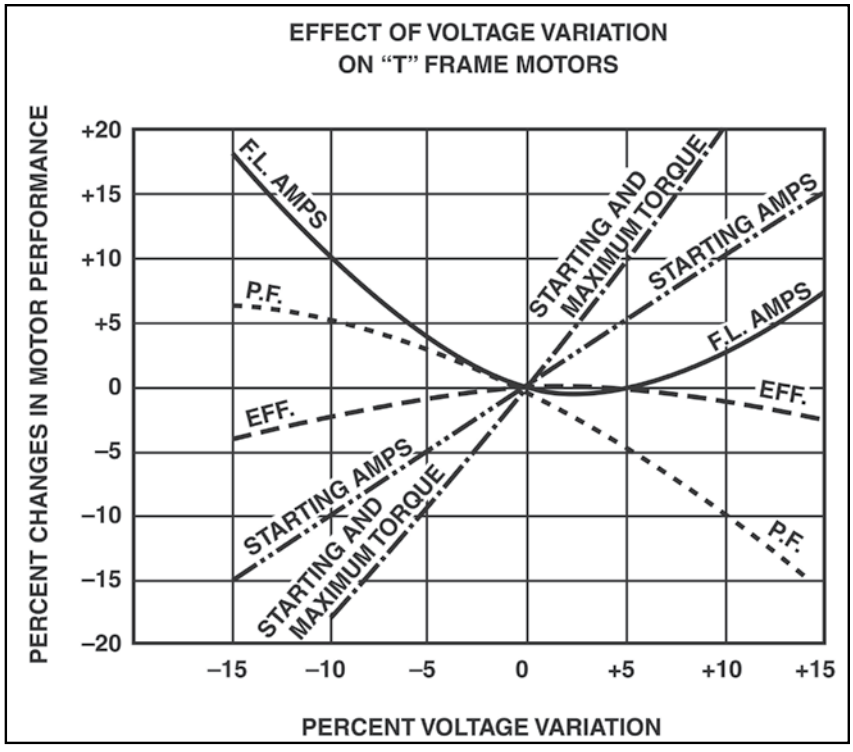


Figure 1 Effect of voltage variation on T-frame motors; percent voltage variation.

Although this presentation covers the effects of high and low voltage on motors, the operation of other magnetic devices are affected in similar ways. For example, solenoids and coils used in relays and starters are punished by high voltage more than they are by low voltage. This is also true of ballasts in fluorescent, mercury, and high-pressure sodium light fixtures. Transformers of all types, including welding transformers, are punished in the same way. Incandescent lights are especially susceptible to high-voltage conditions. A 5% increase in voltage results in a 50% reduction in bulb life. A 10% increase in voltage above the rating reduces incandescent bulb life by 70%.

Overall, it is definitely in the equipment's best interest to have the utility company change the taps on incoming transformers to optimize the voltage on the plant floor to something that is very close to the equipment ratings. In older plants, some compromises may have to be made because of the differences in the standards on old motors (220/440) and the newer "T" frame standards (230/460); but a voltage in the middle of these two voltages, something like 225 or 450 volts, will generally result in the best overall performance. High voltage will always tend to reduce power factor and increase the losses in the system, which results in higher operating costs for the equipment and the system.

The graph shown in Figure 1 is widely used to illustrate the general effects of high and low voltage on the performance of "T" frame motors. It is okay to use the graph to show "general" effects, but bear in mind that it represents only a single motor and there is a great deal of variation from one motor design to the next.

For example, the lowest point on the full-load amp line does not always occur at 2½% above rated voltage. On some motors it might occur at a point below rated voltage. Also, the rise in full-load amps at voltages above rated tends to be steeper for some motor winding designs than others.

Some general guidelines might be useful.

1. Small motors tend to be more sensitive to over-voltage and saturation than large motors.
2. Single-phase motors tend to be more sensitive to over-voltage than three-phase motors.
3. U-frame motors are less sensitive to over-voltage than "T" frames.
4. Premium efficiency Super-E motors are less sensitive to over-voltage than standard efficiency motors.
5. Two-pole and four-pole motors tend to be less sensitive to high voltage than six-pole and eight-pole designs.
6. Over-voltage can drive up amperage and temperature — even on lightly loaded motors. Thus, motor life can be shortened by high voltage.
7. Full-load efficiency drops with either high or low voltage.
8. Power factor improves with lower voltage and drops sharply with high voltage.
9. Inrush current goes up with higher voltage.

Summary

There are very few desirable and many undesirable things that happen to electric motors and other electrical equipment as a result of operating a power system at or near the ends of voltage limits.

The best life and most efficient operation usually occur when motors are operated at voltages close to the nameplate ratings. **PTE**

EASA

PRESENTS EXCEPTIONAL ACHIEVEMENT SERVICE AWARD

The Electrical Apparatus Service Association (EASA) honored Art Anderson as the 2017 recipient of the EASA Exceptional Achievement Service Award. The presentation was made on June 25, 2017, at the Association's Annual Convention in Tampa. Florida.

Established in 1997, this annual award recognizes an individual who has provided exceptional service to the electrical apparatus sales and service industry over a lifetime. "It is the highest honor an individual can receive from our association," says Linda Raynes, EASA president and CEO. "We view it as our Nobel Prize for achievement and service."

Anderson started his career in the electrical apparatus business at an early age. That's because his father, James J. Anderson, was a service center owner/manager and was very active in EASA. His father served as EASA's International president in 1972-3. Anderson followed his father and served in the same position for EASA in 2006–7.

(Left to right) Mike Dupuis, EASA past chairman and Art Anderson, award recipient.

In announcing the award, EASA's Past Chairman, Mike Dupuis noted "Art once said that his father had vision and passion for EASA — that it be the very best technical and educational resource in our industry. While he had many accomplishments during his years of service, Art Anderson's most recent contribution was serving as chair of the EASA Ad Hoc Committee on Accreditation. As a member of that committee, I can tell you he did an exemplary job for which we should all be grateful."

In nominating Anderson for this award, one letter from a repair firm member read: "He is one of those special individuals who has given much to EASA in a very unassuming way. His quiet mannerism allows him to listen and then give a view that is always reasonable and to the point."

Another member wrote: "Following in his father's footsteps, he has displayed true 'exceptional achievement' in both his ability to run a service center and be an outstanding EASA member."

One final letter noted: "He praises others and plays down his contributions on any team, even though he is the one out front doing the leg work on any project and pushing it through completion." (*www.easa.com*)

Lafert North America

APPOINTS SALES REPRESENTATIVE AND ACCOUNT MANAGER

Lafert North America, a manufacturer of metric AC Motors, metric gearboxes and coolant pumps, is pleased to announce the appointment of Eric Cheung to the role of sales representative. Cheung brings seven years of experience in the power transmission (PT) industry in technical support roles using his mechanical engineering knowledge to build customer relations and deliver positive value. He holds a mechanical engineering technologist designation from Centennial College, Ontario Canada.

Mario Hartard has been appointed to the role of account manager/business development. Hartard brings 17 years of experience in the electrical power industry and has developed expertise across the North American market in the area of mines and metals, public utilities and oil and gas. He holds a B.S. in Industrial Engineering from Universidad Iberoamericana — Mexico. *[www.lafertna.com]*

Yaskawa Motoman

APPOINTS VP OF NORTH AMERICAN SALES AND MARKETING

Yaskawa Motoman recently announced that Doug Burnside has been appointed Vice President of North American Sales and Marketing. In this position, Burnside will be responsible for establishing and executing strategic business direction to drive growth in the North American market, as well as leadership for all sales and marketing activities.

Burnside, previously Vice President of Customer Satisfaction for Yaskawa Motoman, offers invaluable industry experience and customer focus. "Doug has made many important contributions to our company," said Steve Barhorst, President and COO of Yaskawa Motoman. "His industry expertise and knowledge of our customers' needs will help to drive and increase growth in sales, as well as help achieve our long-term goals."

Since joining Yaskawa Motoman in 2005, Burnside has been a key leader of the Customer Satisfaction Group (CSG) team, contributing significantly through the development

and implementation of various customer care and aftermarket sales programs.

Earlier in his career, Burnside managed operations, sales and support at several software and telecommunications companies. He holds a Bachelor of Business Administration degree in Finance from Western Michigan University. (*www.motoman.com*)

HBM Holdings

ACQUIRES SCHAFER INDUSTRIES

HBM Holdings (HBM) has announced that it has acquired Schafer Industries (Schafer) of South Bend, Indiana. Schafer is a leading producer of high-precision, custom-engineered gears and machined parts for a wide range of applications, as well as transaxles, brake assemblies and other components for off-road vehicles. The acquisition of Schafer is a continuation of HBM's long-term strategy to acquire and build market leading manufacturers of industrial products.

"We are thrilled to bring Schafer into our portfolio," said Mike DeCola, HBM's CEO. "Schafer's leadership team has done a remarkable job of growing the company by helping customers solve complex problems. Building on this success, we look forward to further expansion of the business. Schafer is a perfect fit for our model, as the current ownership group is ready to transition the business to reach a new level of capability and success," continued DeCola.

Founded in 1934, Schafer is a privately held company operating through two vertically integrated divisions: Schafer Gear Works and Schafer Driveline. Schafer Gear Works manufactures gears that power products across a diverse set of markets and custom applications, including aerospace, industrial warehouse equipment, and general transportation applications found in the automotive, agricultural and construction sectors. Schafer Driveline is a leading manufacturer of custom engineered and assembled transaxles and brake components, bringing integrated power delivery solutions to the recreational and off-highway vehicle industries. In total, Schafer operates four facilities in the Midwestern United States, with over 300,000 square feet of manufacturing space.

Bipin Doshi, CEO and president of Schafer, commented, "As we engaged in the process of selling Schafer, our priorities were our employees and our customers. Throughout the process, HBM Holdings stood out not just in value for us as shareholders, but in terms of cultural fit. They understand our markets, technology and resource constraints and have a talent development strategy that will help our people continue to grow and succeed. Their focus on growth will benefit both our employees and our customers."

Doshi, along with his wife Linda, and Stan Blenke, executive vice president and CFO, acquired the business from South Bend Lathe approximately 30 years ago. As a result of their leadership, the company has experienced tremendous

expansion organically and through acquisitions. Both Doshi and Blenke will stay involved during a transition period.

Eric Van Rens will become the company's CEO effective immediately. Since 2004, he has served as the vice president, sales and marketing for Mississippi Lime, an HBM portfolio company. He also held prior roles in operations, marketing and general management with Astaris and FMC Corporation. He holds a bachelor's degree in mechanical engineering from University of Wisconsin and a master's of business administration from Rutgers University.

(*www.schaferindustries.com*)

Regal Beloit

LAUNCHES NEW WEBSITE

Regal Beloit Corporation has launched a new, responsive website platform with significant upgrades, additional product features and a focus on industry solutions. The company's approach to convert each of its brand-specific domains to the new company-wide platform will occur in phases, starting with the Marathon Motors North American site.

The new website design takes an industry-based approach enabling customers to streamline product searches and selection throughout Regal's portfolio for solutions specific to their application.

"It has become increasingly more important to provide our customers with a website that provides solutions that include all products relevant to a specific industry," said Paul Goldman, vice president of marketing and communications, Regal Beloit Corporation. "We will continue to increase the breadth and depth of product information through successive rollouts to further enhance the industry solution approach."

The new design delivers a robust product evaluation experience including product search filters, a competitive product cross-reference tool, expanded specs and complementary parts information. With a new rotating 3D format, website visitors can get an enhanced look at products on the site. New navigation tools allow customers to view products based on solution and application within a specific industry.

"Our goal is to create an integrated Regal brand experience that provides customers with access to rich product information," said Goldman. "We also focused heavily on expanding the available product specs, enabling customers the ability to make more informed decisions."

View the new website at the link below:

(*www.regalbeloit.com*)

Schaeffler and Fraunhofer

SIGN PARTNERSHIP AGREEMENT

What do the factories and workplaces of the future look like? How can emission-free, intelligent mobility for tomorrow be created in increasingly digitalized urban environments? These are topics that Schaeffler and Fraunhofer will be strategically working to tackle in the long term. Regularly exchanging information about the changes going on in the world and the resulting challenges and opportunities are important elements of the partnership for both parties.

"Future mobility will be characterized by new forms of transportation in urban areas. Schaeffler has made an early start here by developing the Schaeffler Bio Hybrid — a vehicle that represents emission-free, requirement-based mobility. Digitalization is set to bring about further changes to today's world and make service-oriented business models possible in all sectors of industry. We are delighted to have Fraunhofer — Europe's largest research organization for application-oriented research — on our side here", said Prof. Dr.-Ing. Peter Gutzmer, CTO at Schaeffler AG, at the signing ceremony for the strategic partnership. Fraunhofer is an important partner in Schaeffler's global research and innovation network, which as an addition to the "SHARE" ("Schaeffler Hub for Advanced Research") company-on-campus concept and the company's collaboration with startups is based on several pillars.

For Schaeffler and Fraunhofer, the aim of this partnership is to bring technologies into practical applications in an even faster and more targeted manner. During the last few years, this collaboration has continuously been expanded and enhanced, the focus being on the topics of manufacturing technology, materials and coating technology, tribology, eco-friendly drives, and energy storage. (*www.schaeffler.us*)

Standard Locknut LLC

NAMES VICE PRESIDENT OF SALES AND MARKETING

David White has joined Standard Locknut LLC as vice president of sales and marketing. In this role, White will drive Standard Locknut's strategic product and market expansion while enhancing OEM and Distribution relationships. David will also be promoting the integration advantages of both Standard Locknut and Miether product lines.

Previously, White served as NTN Bearing Corporation's director of industrial marketing. While there, he accelerated growth through product development and broadened brand presence in the aftermarket. Both experiences will serve Standard Locknut's 2017 strategic direction and beyond. He also served as Timken's general manager for global industrial services and director of sales and marketing in India.

"We're very fortunate to have David join the Standard Locknut team and look forward to his contributions to our growth initiatives," said Kevin L. Herkner, Standard Locknut's President and COO. "His 25 years of industry experience will help drive significant growth and deliver improved business performance."

Preceding his working career, White earned his MBA from Case Western and his BS in mechanical engineering degree from Virginia Tech. (*www.stdlocknut.com*)

Stiebel Drive Technology

WELCOMES USA SALES MANAGER

Stiebel Drive Technology is now strengthening its sales expertise in the North American market with the appointment of Timothy Ruiz. The multilingual engineer is assuming the position of USA sales manager. He was previously employed in sales roles at industrial concerns such as Bosch Rexroth, SKF & Ringfeder North America and brings corresponding experience for the U.S. market. At Stiebel, the 43-year-old will take responsibility for further expanding the OEM business of internationally operating customers in particular.

Paul-Hermann Schumacher, managing partner of the Stiebel Group, is pleased with this addition to the Stiebel team: "By making this commitment, we are systematically pursuing our previous path of growth in North America. His experience as an engineer and in the key account business makes Timothy Ruiz a valuable addition to our company and our customers." Stiebel is expecting Ruiz to further promote sustainable networks with its customers worldwide.

(*www.stiebel-drives.com*)

Desch Group

ANNOUNCES U.S. OFFICE

Desch is a family-owned company with over 111 years of experience in the field of modern mechanical and plant engineering. As a market-leader in drive technology, the company uses of state of the art technological advanced manufacturing, offering its customers innovative and customized system solutions along the entire drivetrain. Offices are located in Akron, Ohio. For future sales related inquiries on gearboxes, clutches and couplings, please contact the U.S. team. (*www.desch.com*)

Stauff Corporation

APPOINTS DIRECTOR OF SALES - KEY ACCOUNTS

Stauff Corporation announces the appointment of Chad Phillips to the new position of director of sales – key accounts. With his solid industry experience coupled to his energetic approach to business, he will strategically drive Stauff's efforts in gaining market share in the important Off-highway OEM sector.

Previously, he served as the vice president of sales and marketing for Faster, a leading international Quick Release Coupling manufacturer. Prior to this, Phillips served as the vice president of sales for Tuthill Controls Group, now known as Cablecraft Motion Controls, whose main customers were both on-highway and off-highway OEMs. He began his career at Dana's Fluid Systems Group.

Although his most recent experience is in sales management, Phillips is an engineer with sound knowledge in lean manufacturing and is a 6 Sigma Black Belt. Phillips, his wife Melisa and their three children live in Rockwell, NC (near Charlotte). (*www.stauffusa.com*)

September 19–22—Process Expo 2017 McCormick Place, Chicago, Illinois. Process Expo represents the pinnacle of food technology bringing together the world's most successful food and beverage processors, equipment manufacturers and leaders in the field of academia. It is owned and organized by the Food Processing Suppliers Association (FPSA), a global trade association serving suppliers in the food and beverage industries. Nearly 600 food processing and packaging exhibitors will display machines, products and services specific to food and beverage processing. For more information, visit *www.myprocessexpo.com*.

September 25–27—CTI Symposium China With eight lecture series, 60 presentations, seven keynote speeches and the satellite exhibition "Transmission Expo," the event will provide a powerful framework for high-ranking Chinese and international automobile and transmission manufacturers and suppliers. The focus will rest on strategies, new components and development tools for conventional and alternative drives. With over half a million electric vehicles sold in 2016, China is now by far the world's largest market for plug-in hybrid and electric vehicles. Supported by state programs and directives, NEVs (New Energy Vehicles) aim to cut emissions in urban conglomerations and make the land less dependent on oil imports. By 2020, the plan is to get more than five million electric automobiles on Chinese roads. For more information, visit *www.transmission-symposium.com/china*.

September 25–27—Pack Expo 2017 Pack Expo Las Vegas, North America's largest packaging event of 2017, will bring together the solutions needed to launch new products and solve production issues. Corporate managers, engineers, sales managers, plant managers, manufacturers and production supervisors, brand and marketing managers, quality controllers, purchasers, research/development and package designers from a wide variety of consumer packaged goods companies (CPGs) will be in attendance. More than 2,000 exhibitors will display state-of-the-art technologies, equipment and materials. The show is co-located with the Healthcare Packaging Expo, bringing pharma/biopharma, nutraceutical and medical device manufacturers together for the latest trends, innovations and solutions. For more information, visit *www.packexpolasvegas.com*.

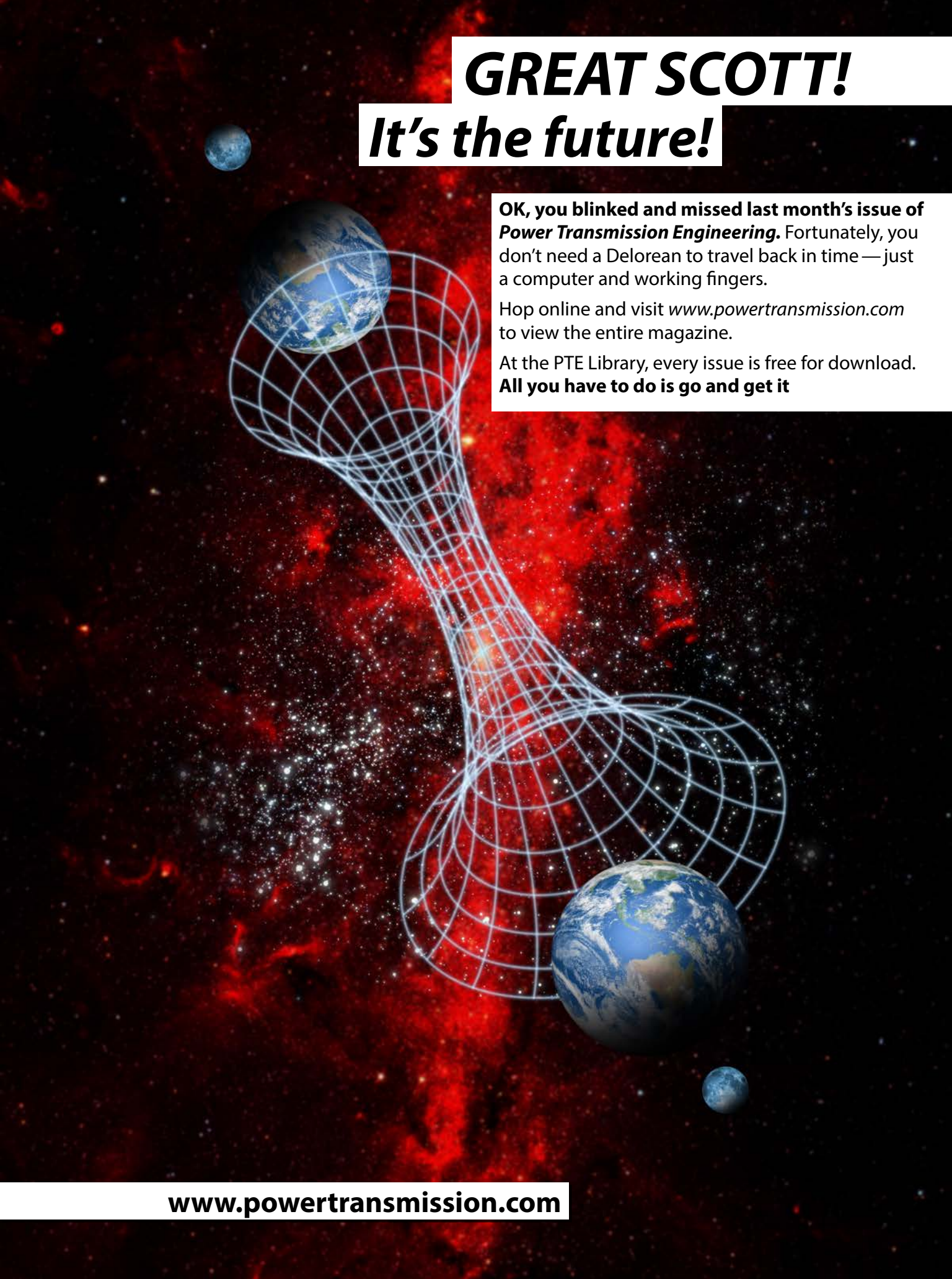
September 25–28—Canadian Manufacturing Technology Show 2017 The International Center, Mississauga, Ontario. The Canadian Manufacturing Technology Show, based in Toronto, is Canada's national stage for manufacturing technologies, best practices and industry connections. For more than 30 years, the CMTS audience from within Canada's leading industries, including automotive and aerospace, have come together to source solutions and knowledge from the global leaders in machine tools and tooling, metalworking, and advanced manufacturing. CMTS provides attendees from all walks of manufacturing an experience they never forget and often repeat: a hands-on, flexible learning environment of revolutionary technologies. Experience more than 3,000,000 lbs. of manufacturing equipment in action and connect with 700+ suppliers of technologies and solutions under one roof demonstrating live, working equipment. For more information, visit *www.cmts.ca*.

October 4–6—AGMA Steel for Gear Applications Alexandria, VA. This course provides detailed information to make use of steel properties in a system solution and understand the potential that different steel options can offer for various applications. Students will explore the how the production of the steel can affect the performance of the material and also the final component and system. The course will be facilitated by Lily Kamjou, a senior specialist in Ovako's Industry Solutions Development department. It is an advanced level course and qualifies for those individuals pursuing the Advanced Gear Engineering Certificate. For more information, visit *www.agma.org*.

October 4–6—20th Manufacturing World Osaka, Japan. Manufacturing World includes three exhibitions: Mechanical Components and Materials Technology Expo; Design Engineering and Manufacturing Solutions Expo; and Factory Facilities and Equipment Expo. Special sessions at the event include "We Shape Industry 4.0," by the Bosch Corporation and "New Manufacturing in the IoT Era," by Konica Minolta. 20th Manufacturing World Osaka is the Western Japan's largest trade show, specializing in the products, technologies and solution for the manufacturing industry. All kinds of mechanical parts/subcontracting services (fasteners, springs, tube components, etc.), materials/equipment for factory (heaters, fans, harness, helmets, etc.) and IT services (CAD, CAM, production system management, etc.) are exhibited under one roof. For more information, visit *www.japan-mfg.jp/en/Home_Osaka*.

October 24–26—Gear Expo 2017 Columbus, Ohio. For three days, the full range of drive technology experts—design, manufacturing, application engineering, gear buyers and manufacturers—network and build relationships that benefit their respective companies. For the past six years, AGMA's Gear Expo has been growing and expanding with more suppliers and attendees meeting to build new partnerships and explore the latest technology on the market. Attendees represent a variety of industries including off-highway, industrial applications, automotive, and oil and gas as well as aerospace, agriculture and construction. They come from around the United States, international manufacturing hubs, and emerging markets to conduct profitable business transactions and collaborate on the innovations that make their operations more streamlined. The show is co-located with the ASM Heat Treating Society Conference and Exposition. For more information, visit *www.gearexpo.com*.

October 24–26—South-Tec 2017 TD Convention Center, Greenville, S.C. South-Tec draws manufacturing suppliers, distributors and equipment builders from across North America and around the world - bringing them together in Greenville, South Carolina. With hundreds of exhibiting companies, attendees can find all the latest technologies and services - plus the experts who build them - ready to demonstrate solutions that can help them grow their business. Visitors can make side-by-side comparisons, discover integrated equipment, hear about industry trends and forecasts, and leverage their purchasing power. For more information, visit *www.southteconline.com*.



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☐ WE DESIGN products with power transmission components in them. (16)
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The Hyperloop is Here — Sort of

Jack McGuinn, Senior Editor

Photo courtesy Hyper One.

It is unlikely the hyperloop will inspire Hollywood to start making films emulating the tried-but-true terror-on-a-train genre — a genre that includes many classics. But somehow titles like — *Lady on a Hyperloop*, *Strangers on a Hyperloop*, *Murder on the Hyperloop Express*, *Throw Momma from the Hyperloop*, *The Great Hyperloop Robbery* — just don't work. And you can forget about another venerable train travel tradition — the club car — given that you will probably reach your destination sooner than you can say "Jack on the rocks."

But forget all that — the hyperloop is about *speed* — speed to burn (pending full funding, that is).

Boy Wonder Entrepreneur Extraordinaire Elon Musk of Hyperloop One (there's a Two and a Three elsewhere) says he has "verbal" approval from Washington to build an underground hyperloop between New York and Washington, D.C. What is normally a three-hour train trip — 75 minutes by air — the Hyperloop can complete in 29 minutes — at *700 mph*. The route would also include Philadelphia and Baltimore. (Musk's involvement in the project is limited to building the tunnels; it is not yet clear which firm he plans to partner with to handle the pod vehicles.)

How soon will this happen? Musk recently tweeted that there's "still a lot of work needed to receive formal (DOT, etc.) approval," yet he's optimistic — *of course* he's optimistic, he's Elon Musk! — that it "will occur rapidly." Defining "rapidly" is the tricky part. And if you folks living in, for example, Atlanta, Chicago, or Minneapolis are experiencing hyperloop envy — Musk implores you to contact your elected representatives and ask them to support building more hyperloops — a hyperloop hypapalooza!

Indeed, the concept-to-completion loop just got a bit tighter; in late July the company announced the "successful completion of its second phase of testing. On July 29th, Hyperloop One achieved historic test speeds traveling nearly the full distance of the 500-meter DevLoop track in the Nevada desert. The Hyperloop One XP-1, the company's first-generation pod, accelerated for 300 meters and glided above the track using magnetic levitation before braking and coming to a gradual stop."

How does that work?

Well, a hyperloop "blasts passenger pods down vacuum-sealed tubes" (coursing) from New York to Washington — at near-supersonic speed. "The pods would rocket along rails through reduced-pressure tubes at speeds of 750 mph."

Hyperloop One says the technology provides better safety than passenger jets, lower build and maintenance costs than high-speed trains, and energy usage, per person, that is "similar to a bicycle."

When considering the principle upon which the hyperloop is based — it can get a little wacky.

Those old enough and Turner Classic Movies fans are perhaps somewhat aware that "pneumatic tubes (or capsule pipelines, also known as pneumatic tube transport or PTT) are systems that propel cylindrical containers through networks of tubes by compressed air or by partial vacuum. They are used for transporting solid objects (hyperloop extrapolation here: that would be *passengers*), as opposed to conventional pipelines that transport fluids. Pneumatic tube networks were popular in the late 19th and early 20th centuries for offices (think newspaper newsrooms, department stores, large banks, etc.) that needed to transport things such as mail, paperwork, or money over relatively short distances (within a building, or at most, within a city) in a very short time." (*Source: Wikipedia*.)

And now we have — or will have — the hyperloop.

Other companies looking at the hyperloop technology include Northeast Maglev, and Hyperloop Transportation Technologies. Hyperloop One is looking to get three systems underway, according to a statement by chief executive Rob Lloyd.

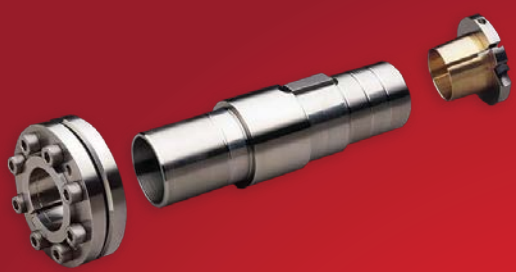
Also, richer-than-Croesus DP World Group of Dubai has invested in the concept, as well as French rail company SNCF, General Electric and Russian state fund RDIF.

"Hyperloop One has accomplished what no one has done before by successfully testing the first full-scale hyperloop system," said startup co-founder and executive chairman Shervin Pishevar in a press release. "By achieving full vacuum, we essentially invented our own sky-in-a-tube — as if you're flying at 200,000 feet in the air."

Systems successfully tested back in May of this year include the motor, vacuum pumping, magnetic levitation, and electromagnetic braking.

And did we mention that Mr. Musk has plans to send two private citizens around the Moon?

And to land an unmanned spacecraft on Mars by 2020? **PTE**



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