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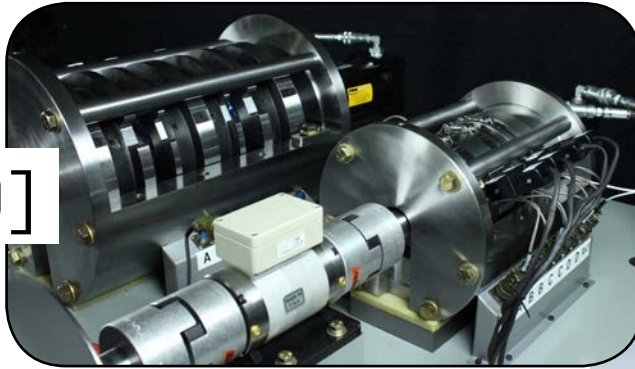
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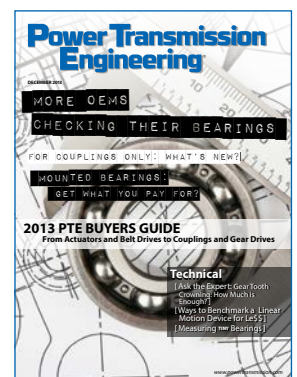
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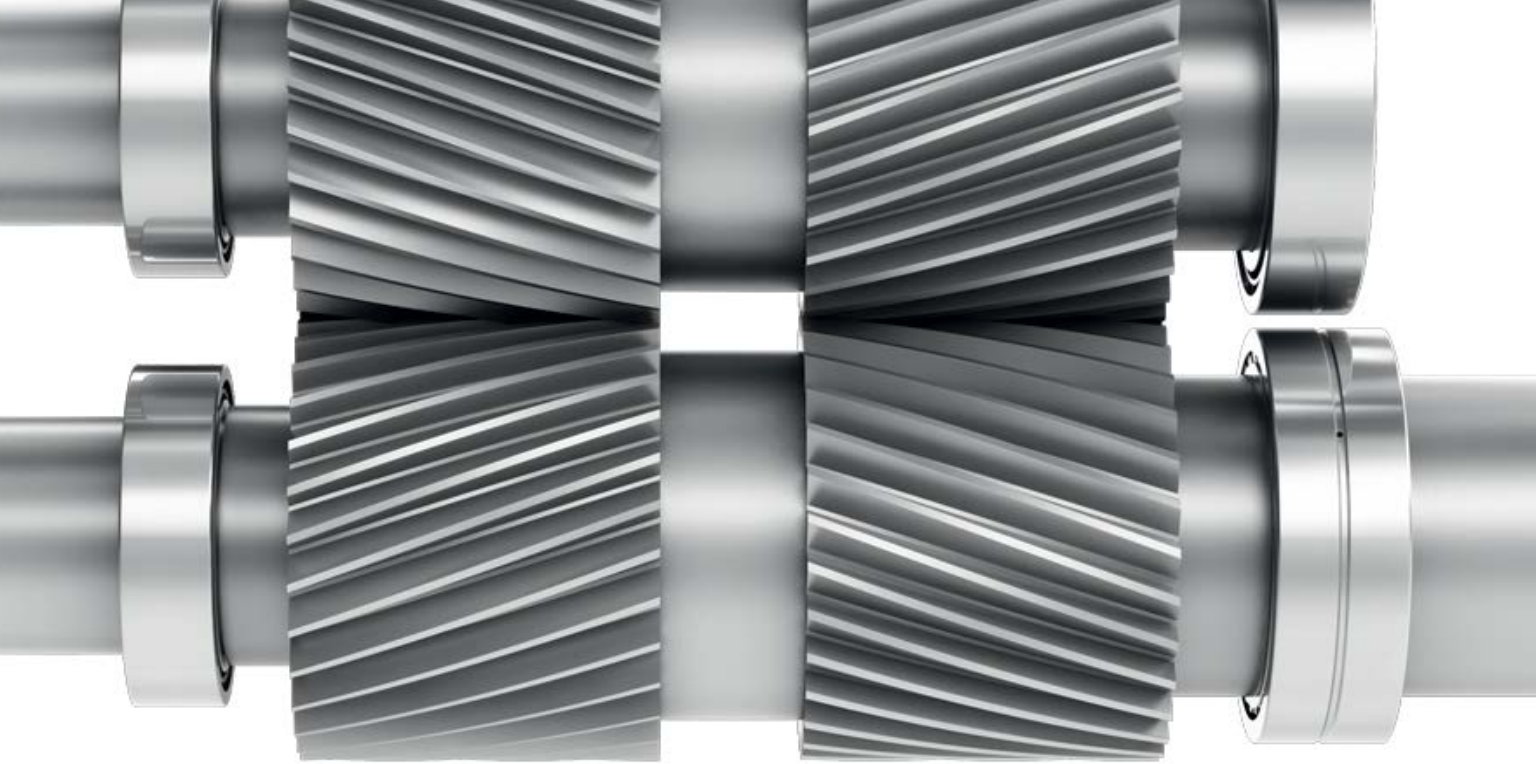
For publication guidelines and more information, please contact Jack McGuinn at jmcguinn@powertransmission.com.

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PTE Facebook: The 2014 NFPA Annual Conference takes place February 3-5 in Florida. For registration, schedule and additional information log-on to the PTE Facebook page (<https://www.facebook.com/pages/Power-Transmission-Engineering/109042075794176>).



Twitter: The PTE Twitter feed keeps readers up-to-date on the latest products and services available to the PT community. Recent products from Aerotech, Voith, SKF, AutomationDirect and Steinmeyer are currently online. Join us at <https://twitter.com/PowerTransMag>.

Ask the Expert: Do you have a question about gears, bearings, motors, clutches couplings or other mechanical power transmission or motion control devices? Submit your questions to our panel of experts at: www.powertransmission.com/asktheexpert.php.



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Randall Publications LLC

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

EDITORIAL

Publisher & Editor-in-Chief

Michael Goldstein
publisher@powertransmission.com

Managing Editor & Associate Publisher

Randy Stott
wrs@powertransmission.com

Senior Editor

Jack McGuinn
jmcguinn@powertransmission.com

Senior Editor

Matthew Jaster
mjaster@powertransmission.com

Editorial Consultant

Paul R. Goldstein

ART

Art Director

David Ropinski
dropinski@powertransmission.com

ADVERTISING

Advertising Sales Manager & Associate Publisher

Dave Friedman
dave@powertransmission.com

Materials Coordinator

Dorothy Fiandaca
dee@randallpublications.com

CIRCULATION

Circulation Manager

Carol Tratar
subscribe@powertransmission.com

RANDALL PUBLICATIONS STAFF

President

Michael Goldstein

Accounting

Luann Harrold



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PTE on a Growth Path

We are pleased to present this issue of *Power Transmission Engineering*, featuring our annual printed-version Buyers Guide, a comprehensive directory featuring about 800 suppliers of power transmission components from around the world. Our editors and staff have worked hard over the past several months to ensure that the information presented here is as inclusive and accurate as possible.

A core part of what we do here is making sure that our readers – the people who design, buy and use mechanical power transmission products – know where to find the suppliers of technology they need. In fact, the Buyers Guide has been a big part of our mission since we first launched *powertransmission.com* in 1997. What's more, while the printed guide in your hands provides a handy reference that's easy to use, the online version of the Buyers Guide includes even more comprehensive information, and you can drill down to even more specific product categories. Furthermore, the online Buyers Guide is continually evolving, as new companies are added and changes come in throughout the year.

I'd like to thank all of the suppliers who took the time to get listed and who also helped us by updating and reviewing their information online. Their contributions are at least as important as ours. Of course, I would be remiss in my duties if I didn't also thank the advertisers who support what we do. Your generous support has helped this publication grow and expand over the past seven years.

Thanks to that support, *Power Transmission Engineering* has been able to grow significantly—this past year more so than any year previously. In fact, every aspect of *Power Transmission Engineering* has expanded in 2013. We've added more pages in each issue to bring you as much valuable information as possible, including new features and columns like "Ask the Expert," which brings the technology down to a more practical level.

And there's plenty more growth on the horizon. In fact, beginning in 2014, we're expanding our schedule to publish eight issues instead of six. We'll be adding issues with a special focus on the IFPE show in March and a special focus on MDA, IANA and IMTS in September.

On top of that, we're also significantly expanding our efforts at electronic communication. We know how busy you are, so we're doing



everything we can to make sure you get the information you need in the manner that's most convenient to you. With that in mind, we've stepped up our efforts at communicating via social media, including LinkedIn, Twitter and Facebook, and we're expanding our e-mail distribution as well, with our highly popular "Product Alerts" scheduled for twice a month in 2014, in addition to our regular monthly newsletter.

So far, our efforts seem to be paying off, as we've seen a significant increase in subscriptions, with our overall distribution increasing by more than 13% for 2014 vs. 2013. It's extremely important to us that we deliver this magazine to those who are most interested in it, so please keep those subscription cards coming in. If you haven't renewed in a while, please do so at www.powertransmission.com/subscribe.htm.

In closing, I'd just like to offer everyone in the industry our sincere wishes that you enjoy a very prosperous 2014.

Randy Stott



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Support Engineering

MEETING THE CHALLENGE OF GLOBAL LOGISTICS AND SUPPORT FOR LARGE POWER TRANSMISSION PROJECTS

“The key to supplying and supporting large, operationally critical power transmission equipment on a global basis is a combination of experience, planning and having the right people available on-site virtually anywhere in the world,” says Neil Wright, managing director of Wichita Clutch.

Wichita is part of the Altra Industrial Motion group, which manufactures and supplies a large range of industrial clutches, brakes, couplings and geared motors. As such it can provide valuable insight into how to deliver and support these sometimes huge and usually operationally critical items of plant equipment.

Wright, who is also the managing director of Twiflex Limited, comments on where to locate stock; if point of manufacture matters; what to consider when shipping; and how to manage commissioning and local support. “There are several criteria which come into play when supplying large items of power transmission equipment

are applications where Wichita clutches can be found.”

When you manufacture a niche product, the knowledge and machines required to design and manufacture each item, often to a custom specification, have to be concentrated in a limited number of locations. “This means that we have to be highly proficient with our distribution and delivery network, which is why we have a department dedicated to world-wide logistics and have done so for over 50 years. Paperwork requirements vary wildly depending on final destination, so it is essential for us to have continuity in that department, to learn the most effective ways of doing business and to continue to build-up our cache of local knowledge,” adds Wright.

“When handling paperwork, communication and coordinating after sales support on a global basis it is essential to have local sales offices in every major country that we sell to. It has been a strategic focus for Altra to have a global network of sales offices across North America, South America, Europe and Asia and therefore it

is likely that direct after sales support, from a local speaking national, is never far away.

“For commissioning we predominantly use our own people to complete or oversee a build; we have teams that are trained to handle our products and can travel to most locations in the world. We also have international support engineers that can be deployed locally on all the major continents. We find that having our own people on-site means that we can work more

efficiently and any questions can be answered and issues addressed immediately.”

When selling smaller, more standardized or commodity based items of power transmission equipment, in-country distribution partners and third party sales support make perfect sense. However, when you are dealing with high-value capital pieces of equipment, where each application is different in some way, then there are too many variables to leave the task to someone who isn’t a total specialist. A good way to illustrate how the organization accommodates both sales and ongoing support is to look at a typical example:

Wichita recently designed, manufactured and delivered a large 42" Wichita MSV series marine clutch for a dredging ship. “We have supplied several large clutches to dredging ships before, so there was a degree of accumulated knowledge within the company on this type of application. This one, however, was larger than anything we had produced before,” Wright said.

The clutch couples a three-speed gearbox to a large on-board pump, which is used to provide suction to a trailing hopper that takes-up the river or sea bed and stores it in the ship’s hold. It then changes its operation and is used to empty the hold, either to build-up banks or disperse the material. “Our direct customer is the gearbox manufacturer, so we first started



on a global basis. The ability to both deliver and provide effective technical support for a large item of plant equipment, anywhere in the world, is critical to success. The performance of a supplier on an ongoing basis is also crucial to maintaining a positive working relationship and helping to achieve the customer’s objectives, whether that is to lay a cable across the Atlantic, commission an oil rig, produce steel or even make an island – all of which

to speak to them about the design and specification of the entire application. In this instance this was the largest version of this arrangement ever produced so it involved us designing a bespoke clutch to meet the specifications of this project. Whether a project is large or small, most products with this type of large power transmission system are custom manufactured to a greater or lesser degree; though often based on an existing design. Proper consultation is absolutely essential and, if we are designing to a specification, then it is always best if we can be involved in forming that specification,” Wright said.

Being involved in the design process from the outset is a good example of how the organization works around producing a large piece of custom PT equipment. “We know that we have to be able to provide engineering input from an early stage and commit engineering and design resources to the project before we even start planning the design of the clutch itself. This carries a large overhead, as does maintaining our own logistics teams and commissioning engineers, but it also ensures we are profitable by avoiding the pitfalls of misspecification and out of sequence deliveries.”

Once the design and specification process is complete, the company then designs and manufactures the clutch. In the case of the dredger mentioned above, the gearbox assembly will be supplied to the shipyard for integration into the ship, which means supplying essentially a collection of parts to the shipyard. “We will provide an engineer/project manager to oversee

the assembly and construction of the clutch and then observe the sea trials to make absolutely sure the equipment is performing as expected,” Wright added. “To many companies this may look like overkill, but there are so many variables in a bespoke build of this scale that we find being on-site means we can react to any potential issues as, or even before, they arise. This helps to minimize any potential problems and ensures the project stays on track for our customer. We also go through a thorough check and sign-off process to make sure we are satisfied that the application is working to its operating parameters.”

“The alternative to these checks can be far more difficult and costly. If we are called to look at an issue which arises while a ship or rig is in service, then this can involve flying out engineers (and sometimes tools and parts) to remote parts of the world, finding connecting transport and then possibly helicopter flights out to the vessel itself. Of course our operatives are fully-trained for such an eventuality, from basic site safety through to working in offshore environments, but if we can catch a problem prior to deployment then that is obviously preferable. Often we find that the root cause is not connected with the clutch, but our primary concern is to help resolve the problem.

“When required by our customers we can apply a structured problem solving approach, such as ‘8D,’ to resolve problems. Using this process we look to identify, correct and eliminate any recurring problems. It then allows us to establish a permanent corrective action based on analysis of the prob-



lem; focusing on the origin of the problem and determining its root causes. It is this kind of commitment and attention to detail that we find leads to repeat business – you have to be able to trust and rely on your suppliers, after all.

“Large power transmission projects tend to be by their very nature unsuitable for ‘catalogue solutions.’ Our expertise in such applications allows us to add value to the design process: we work with design engineering departments and help to integrate our CAD models with those of the customer so it is possible to drop them straight into the design. This early partnership saves time and reduces project costs before metal is cut.

“Every company works differently, but when selling and supporting heavy duty clutch and brake products throughout the world, we have developed a model that works for our customers. It is a ‘belt and braces’ approach, as we would say in the U.K. – applying engineers early in the process, taking care of the logistics internally and providing sales and support engineers throughout the world (covering China, Russia, Europe, Asia and the Americas) to look after projects directly – but it results in us being an efficient, reliable supplier in a market that has little or no margin for error.”

For more information:

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Weiss

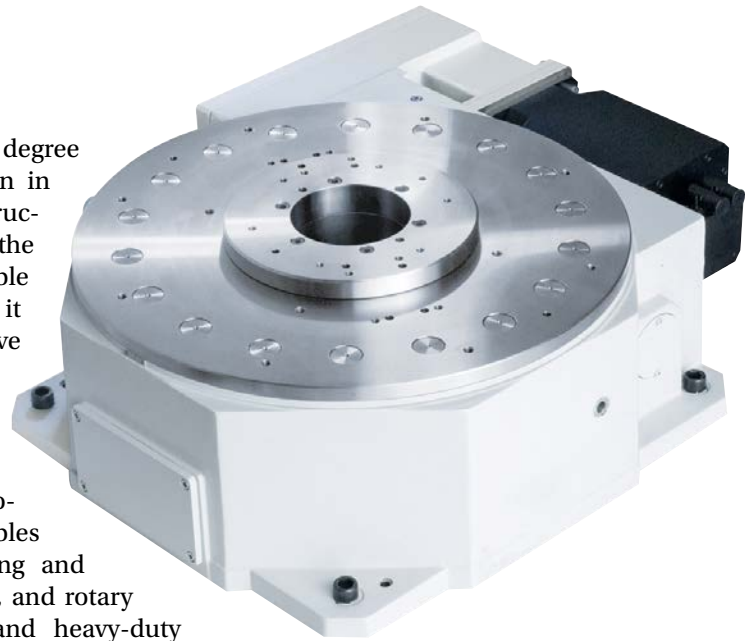
INDEXING TABLES EXPAND PROCESSING OPTIONS

Since the 1980s, SHL (Böttingen, Germany) has been leveraging industrial robots for its automated grinding, polishing, and deburring systems for the automotive, medical, and processing industries. Typically, heavy duty robots with powerful articulated-arms seem somewhat oversized for the delicate tasks and complex geometries such as polishing roof rails and trim for cars. In-depth consultation with Weiss (Buchen, Germany), and its' subsidiary Weiss North America, Inc. (Willoughby, OH), revealed that a powerful robot coupled with a series of heavy duty rotary indexing tables (TC220/NR750/CR750) would provide an optimal standardized and flexible solution. Ultimately, using grinding and polishing machines swivel-mounted on Weiss' rotary indexing tables vastly expanded the processing options for complex geometries and under-cuts.

SHL consulted with Wolfgang Lehnert, technical sales agent at Weiss for the project. "We have a wide range of rotary indexing tables that enable the development of standardized swivelling and positioning units. Using the same dimensions and load data, we offered both fixed-position and user-programmable tables, both with and without their own drive as required. This means we were able to offer SHL

not only a high degree of standardization in design and construction, but also the greatest possible flexibility when it comes to the drive and control system," Lehnert said.

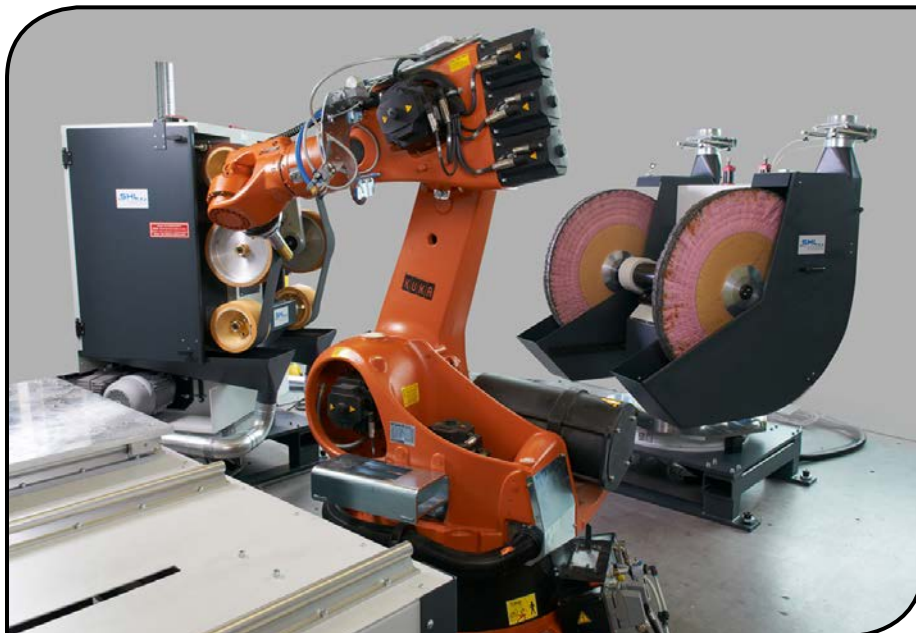
Notably, SHL selected the rotary indexing tables for their swiveling and positioning units, and rotary indexing rings and heavy-duty tables for special solutions without drives. The lightweight design has both of the smaller SHL grinding and polishing machines mounted to a fixed-position Weiss TC220 rotary indexing table. The table rotates in 15-degree steps and swivels the machine a maximum of 90 degrees from the central axis. For the heavy grinding and polishing machines, Oberkampf stated his choice of the user-programmable Weiss NR750 rotary indexing ring, "Our customers want more design freedom with larger installations," he said. SHL also increased use of the Weiss rotary indexing tables for special machines and feeding systems. One such case is the polishing robot, in which a user-



programmable Weiss CR750 heavy-duty table takes care of changing the workpiece carrier.

Weiss' consulting service wasn't just limited to selecting the right rotary index tables. According to Oberkampf, "The Weiss team also supported us in selecting the drive - even though we often order the tables without one." The drive and control system are selected in accordance with the customer's requirements, which means that lots of different motors are used. In some cases, the rotary indexing table is even controlled by the robotic control system as an additional robot axis. According to Lehnert, "Whatever their particular specifications may be, it goes without saying that the end customer expects the system as a whole to be perfectly calibrated. That's why we provided SHL with in-depth consulting at every development step—going beyond just the individual components from the catalog."

The first step is to define the size of the rotary indexing table in line with the specified volumes and dimensions in the concept phase. As soon as detailed construction data and information on the desired drive are available, they contact the drive manufacturer in order to find the optimal motor size and transmission ratio for the application and the table used. Lehnert noted that, "The only way to ensure that the whole system works smoothly is if the



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Fred 'Santa' Young

drive manufacturer, SHL, and Weiss actually get together and work in close cooperation."

Although the drive is not explicitly included in the scope of delivery, Weiss supports the customer in selecting the suitable motor size and transmission ratio in cooperation with the drive supplier. The aim is always to achieve an optimally calibrated complete system. Finally, the SHL robot heaves an enormous polishing unit over the workpieces that the heavy duty rotary indexing tables from Weiss replaces with a fresh batch once processing is complete. To date, more than 1,100 SHL robotic grinding and polishing systems have been implemented worldwide.

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Nexen

EXPANDS ECLIPSE SERVO MOTOR BRAKE LINE

Nexen Group, Inc. has launched an expansion of their Eclipse line to offer more than 140 variations of spring-engaged, air-released servomotor brakes for a wider range of servomotors. Eclipse brakes offer four times the torque of internal servomotor brakes, and offer at least 20-50 percent more torque than competitive brakes, providing greatly enhanced holding power for demanding applications. The Eclipse line offers flanges ranging from 57 mm (2.25 in) to 265 mm (10.43 in) square and shaft diameters from 6.35 mm (0.25 in) up to 48 mm (1.89 in). Nexen offers their expanded range of low-inertia brakes for all major servomotor models up to 20 hp.

“The Nexen servomotor brake design



is elegantly simple, sturdy and sound,” said Ed Brooks, senior technical sales representative, Nexen Group Inc. “This flange-mounted brake is confidently applied by engineers in most industries and out-performs all competitive brakes. This is a product that is easy to apply and performs beyond expectations.”

The new models offer advantages to a more diverse range of industrial applications including packaging machinery, food production, machine tools, conveying systems, CNC machining centers, automotive production equipment, and woodworking. The holding power and positioning accuracy of Eclipse brakes also complement Nexen Roller Pinion System (RPS) systems.

Other features of Nexen Eclipse servomotor brakes include: hightorque (2–125 N-m), NEMA 23, 34, and 42 frame sizes, high torsional rigidity, long facing life,



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true zero backlash for accurate positioning and speeds up to 10,000 rpm. Eclipse brakes are designed to provide responsive and reliable dynamic stopping and holding power for many different industrial applications, can withstand repeated E-stops, and are able to hold loads in place during servo motor change-outs. Eclipse brakes use no power, generate no heat while engaged or disengaged, and require no maintenance.

For more information:

Nexen Group Inc.
Phone: (651) 484-5900
www.nexengroup.com

Stober Drives

EXTENDS PHQ SERIES

Stober Drives, Inc., a high-efficiency gearbox manufacturer in Maysville, Ky., has added two additional sizes to its Servo-Fit PHQ gear unit line. The new sizes are smaller, adding a more diverse range of case sizes. When compared with standard PH gear units, the PHQ allows for higher torque while still providing low backlash and smoothness of operation. The new sizes of the PHQ series include the PHQ4 and PHQ5, which expand the offering to seven case sizes ranging from PHQ4 to PHQ11. The PHQ4 and PHQ5 are available in single- and double-stage, with ratios ranging from 5.5:1 to 55:1.

These gear heads are capable of 430 N-m of acceleration torque. The PHQ7 thru PHQ11 are available in double- and triple-stage, with ratios ranging from 22:1 up to 600:1, and up to 22,000 N-m of acceleration torque. While smaller sizes are now available, all PHQ units utilize a high-torque, four-planet design. This design allows torque to be distributed over four planet gears instead of three. This results in an increase in output torque and torsional rigidity.

“This design enables extreme requirements to be met efficiently and effectively,” said Adam Mellenkamp, product manager at Stober Drives. “Applications in machine tool manufacturing, material handling, robotics sectors, and many other areas can use PHQ.” The PHQ is particularly well-suited for robotics, general automa-

tion, food packaging, injection molding for plastics, and tube-bending industries. With a backlash rating of three arc minutes, the PHQ is ideal for applications requiring low backlash. For applications requiring even lower backlash, the PHQA version is capable of having backlash as low as 1 arc per minute.

For more information:

Stober Drives, Inc.
Phone: (800) 711-3588
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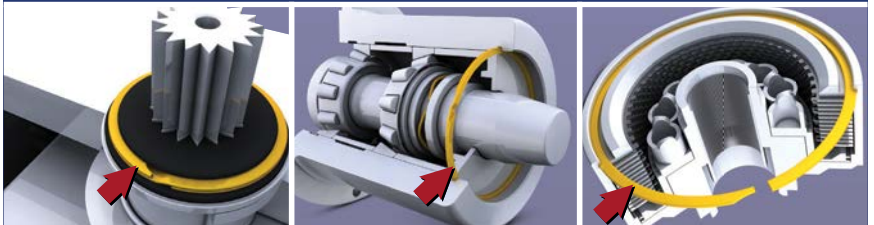


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Rexnord

MANUFACTURES LARGEST FALK RING GEAR

Rexnord has completed the manufacture of its largest Falk Ring Gear in weight and horsepower—250,000 pounds (113,000 kilograms) and 24,000 horsepower (18 megawatts). In terms of weight and horsepower, the ring gear is also one of the world's largest. This six-part ring gear will be used to refine material in a gold mine in the Southwestern United States. The order was placed in March 2012.

With manufacturing beginning in April 2012, numerous Rexnord associates—almost 100—took part in making this giant gear a reality. “From engineering, through the foundry and the machine shop, Rexnord associates have worked efficiently with the customer to produce a high-quality, high-power gearing solution,” says Dave Olson, director, commercial operations, mill products. “Through this tremendous accomplishment, we are demonstrating our company’s expertise and dedication to the industry.”



Gear fast facts:

- Bore size: 443 inches (11,252 millimeters)
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- Face width: 40 inches (1,016 millimeters)
- Number of teeth: 344 teeth
- Tooth depth: 3.4 inches (86 millimeters)
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quality solutions for a diversified range of industries. With a base of more than 5,000 installed ring gears and pinions, Rexnord Falk Mill Products provide solutions for some of the world's most rugged applications. You can find Rexnord Falk Mill Products in the mining, cement, automotive, construction, manufacturing, paper and power generation industries.

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NVision

REVERSE ENGINEERED TURBINE WITH HANDHELD SCANNER

NVision, Inc. recently reverse engineered the rotor assembly, diffusers and diaphragm of a turbine for a major turbomachinery engineering firm in Texas. The full reverse engineering process only took five weeks, far less than the six months that the engineering company had originally allotted for the project using less sophisticated measurement methods. “Us-

ing our own HandHeld scanner, we were able to measure the parts’ geometry to extremely high levels of accuracy and produce the necessary CAD files. This made it possible for the company to perform simulations to optimize the turbine’s design, substantially improving its energy efficiency,” said Steve Kersen, NVision’s vice president of sales and marketing.

The engineering firm specializes in industrial turbomachinery design and power generation engineering, focusing on steam turbine design and power plant engineering, as well as other turbomachinery such as gas turbines, pumps and compressors. The company was tasked with redesigning a turbine so as to optimize its energy efficiency. However, in order to perform the necessary simulations it needed to have the CAD model of the existing turbine, which was not available. “This was a classic scenario for reverse engineering,” said Kersen. “Lacking the original CAD file, the company needed to create a new one by collecting the turbine geometry at the highest possible level of accuracy and in the shortest amount of time.”

The engineering firm contacted NVision, which sent technicians to the firm’s site where they encountered difficult working conditions. The project area was outdoors without a covered structure, which posed a material concern as sunlight would interfere



with NVision's scanning equipment and both the equipment and technicians would be exposed to the elements. Before scanning could begin, NVision technicians worked to drape black plastic sheeting across the top of the work area to protect their equipment and ensure the accuracy of the scanning. They then proceeded to scan the turbine using NVision's HandHeld scanner.

The NVision HandHeld scanner is a powerful portable scanning device that is capable of capturing 3-D geometry from objects of almost any size or shape. The scanner is attached to a mechanical arm that moves about the object, freeing the user to capture data rapidly with a high degree of resolution and accuracy. As a part is inspected, the scanner generates a point cloud consisting of millions of points each with x,y,z coordinates and i,j,k vectors. Integrated software that comes with the scanner is used to convert the point cloud to an STL polygon and an optional tripod provides complete portability in the field. Intuitive software allows real-time rendering, full model editing, polygon reduction, and data output to all standard 3-D packages.

After completing the scanning, which took several days, NVision processed the data to an STL format. The STL file was converted to native parametric *SolidWorks* CAD format so the company could begin the redesign process. The completed *SolidWorks* rotor assembly CAD model contained over 3,000 blades. Upon examining the rotor and diaphragm models, an engineer at the turbomachinery firm wrote to NVision and stated that their work was "very impressive to say the least" and praised the "diligence and caliber" of the NVision team's work.

Kersen agrees. "The adverse conditions at the work site were extremely challenging. Without our technicians' devoted and professional work ethic, the scanning would not have been possible. The completion of this project is a testament to our staff's dedication to customer satisfaction."

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QA1's Ultimate Ball Joints are now offered with additional stud length options and are available pre-assembled. These ball joints and extended length studs were awarded runner-up in the Performance Racing Product group at the 2013 SEMA Show in November. Available in popular bolt-in, press-in and screw-in styles, QA1's ball joints come pre-assembled with standard and up to 1" longer studs. These longer length ball joints can help to improve the overall geometry of the car by increasing straight line stability and improving roll center and can also help to free up bind, allowing the suspension to operate smoothly through the entire range of travel. QA1's Ultimate Ball Joints feature an innovative and durable design to provide

infinite preload adjustment, break-away torque on these ball joints can be as low as 0 ft. lbs. enabling completely smooth, bind-free operation. Engineered to withstand years of use, QA1's ball joints feature precise ball-to-race conformity that provides an even load distribution for unbeatable wear resistance and increased longevity. With their simple construction and assembly, these ball joints can easily be owner rebuilt, cleaned and inspected, and can even be adjusted while still installed on the vehicle.

For more information:

QA1
Phone: (800) 721-7761
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Maxon

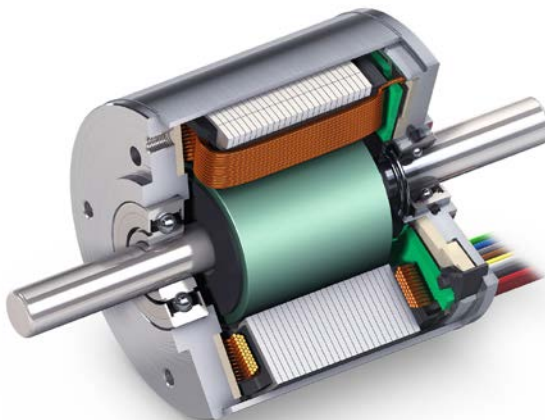
INTRODUCES EC-I MOTOR REDESIGN

In automation and robotics, many applications are characterized by high energy and high torque at the same time. Spatial restrictions also mean that drives must be short, have a long service life and be maintenance-free. The newly redesigned EC-i motors from Maxon Motors offer solutions that fit these requirements perfectly. These brushless DC motors have several key advantages: low inertia, minimal detent, robust bearings and compact construction. The use of high-powered permanent magnets ensures high power density, providing great speed stability under load. These motors are available in 40 mm diameter and in two lengths, namely 26 mm (50 Watt) and 36 mm (70 Watt). The modular system with gearheads, encoders and controllers from the Maxon delivery program offers a large

number of possible combinations. EC-i motors are ideally suited for applications that require maximum drive in a minimum space. Typical areas of application are robotics, industrial automation and security technology.

For more information:

Maxon Motors
Phone: (508) 677-0520
www.maxonmotorusa.com



Emerson

PROTECTS TURBOMACHINERY DRIVES WITH SHEAR SPACER

The Kop-Flex high-speed shear spacer coupling uses a patented double-tube design, precision machining and bearings, and special metal treatments to help provide predictable shear during torque overloads on turbo drivetrains, allowing safe coast down of systems turning at up to 20,000 rpm. Developed to protect gas-turbine-powered generator drives during electrical faults, the shear spacer is also ideal for drives on compressors, pumps, fans and trains subject to shock torques. The patented shear cartridge uses special bearings between two tubes to maintain concentricity and overall centering after high-speed separation. The double-bearing design, precision grooving, shot peening and a corrosion resistant coating combine to increase fatigue resistance and promote reliable operation over the life of the coupling. The high-speed shear spacers are available in all catalog coupling sizes capable of handling

speeds up to 20,000 rpm and millions of inch-pounds (or Newton-meters) of torque.

The high-speed shear spacer is an improvement over standard shear spacers and shear pins, which can create issues when used above 3,600 rpm due to balancing issues and fret-



ting potential when using pins. “Standard shear spacers are not engineered to survive the unbalance forces that develop when turbo drivetrains hit a torque overload at high speeds (3,600-20,000 rpm),” said Joe Corcoran, manager of global services and training for Emerson’s Kop-Flex coupling business. “Coast down from high speed can be unpredictable with a standard shear spacer, and more damage can result. “This design takes the standard shear spacer concept to a whole new level of technology,” said Corcoran. “We start with a comprehensive understanding of the material properties of each unique unit, and use metal treatments, testing, precision machining and special bearings to create a custom shear spacer for each application.”

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Napoleon Engineering Services: Rigged for Success

By Jack McGuinn, Senior Editor

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bearings

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For design engineers and purchasing agents alike, bearings can sometimes be like family. Oh, you know—can't live with 'em, can't live without 'em.

In other words, bearings are vital, problematic components used in both the simplest and most sophisticated gear systems. If it has gears, it has bearings. So it is important to know whether that shipment of new bearings about to arrive and to be incorporated into the gearboxes you are assembling is in top-notch order.

That is where a company like Olean, NY-based Napoleon Engineering Services (NES) steps up to make that happen. In fact, when it comes to bearings, they make a lot of things happen.

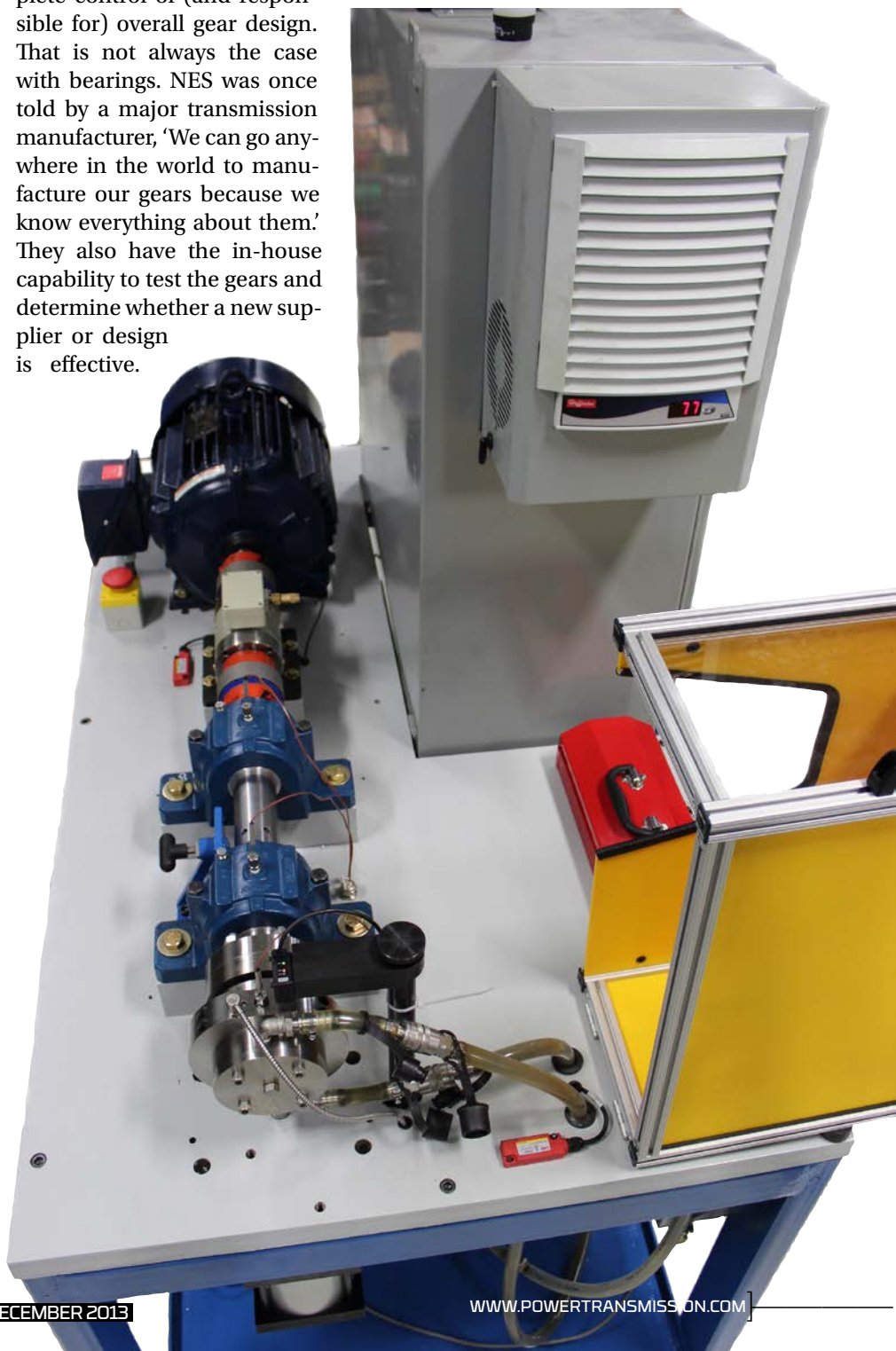
“Actually, as the largest independent bearing inspection and testing facility in North America, we see just about everything,” claims Chris Napoleon, company president, founder and chief engineer. “We also have another aspect of NES that enhances our knowledge base—we also manufacture custom bearings. As a small custom bearing manufacturing facility, we are on the ground floor with the necessary flexibility to incorporate some of the latest technology in bearing design and manufacturing. If we're not making specialty bearings for industrial and aerospace OEMs, then we are testing bearings for the bearing manufacturers and feeding “proprietary” test data to their application engineers and research scientists with information about some of the design advancements they are working on.”

And the OEMs Napoleon refers to are high on the food chain—GM and John Deere are two of them.

Despite the importance of the work, the manufacturing protocols of bearing inspection and testing, while easily as important as any other, do not seem to draw much trade press love. Is it *all* about the gears?

Napoleon responds that, “Historically, many gearbox and transmission OEMs also manufactured their own gears. As a result, they were in complete control of (and responsible for) overall gear design. That is not always the case with bearings. NES was once told by a major transmission manufacturer, ‘We can go anywhere in the world to manufacture our gears because we know everything about them.’ They also have the in-house capability to test the gears and determine whether a new supplier or design is effective.

(But when we) told the same OEM that we needed to know more about their bearing design, they immediately (back-tracked), saying, ‘We don't want



to tie the hands of the bearing manufacturer.' Testing and inspection of bearings themselves, historically, has not been performed by OEMs. (But) as OEM desire for a global supply chain increases, it becomes vitally more important that they take greater ownership in the design.)" And perhaps more to the point of the original question—it appears high-tech bearings are simply too hush-hush and proprietary to be bandied about in the press.

Along with the knowledge, experience and infrastructure necessary to do this kind of work is another NES asset—their Source Qualification Inspection (SQI) program. All of this experience and structure are used in conjunction with what is arguably the backbone of the company's success: their line of bearing test rigs.

"(Our) internal testing program starts with our Source Qualification Inspection program," says Napoleon. "It's a destructive test of a sample of bearings from both the original qualified bearing supplier and any number of new suppliers that the OEM desires to evaluate. The SQI involves dimensional inspection, noise testing, visual inspection, seal evaluation, material chemistry and microstructure. It's always the first step; we don't want to test product that isn't test-worthy. Following SQI we evaluate the failure mode of the bearing in the application. This SQI and test data information are provided to the OEM so they can make an informed decision about a supplier. This is a typical in-house test program and is the model for bearing testing."

NES bearing test rigs run the gamut—capable of testing bearings both simple and sophisticated—leaving no potential failure—or disaster—undetected. This is borne out by the diversity of NES customers and the technical complexity of their needs. Napoleon explains:

"NES offers several standard testing methods and rigs; however, each customer has different bearing sizes and types that they are interested in testing. They also have different test parameters for load, speed, lubrica-

tion, duty cycle or test protocols that they might want to follow. As a result, we design and build the rigs appropriately to OEM needs. The more we can standardize the test rig, the lower the overall cost of ownership—understanding that certain applications and OEM needs may dictate some very unique test parameters or control features. Those OEMs who make the investment in a test rig are also making

an investment beyond just qualifying a new source of supply. They now have the ability to examine how design and manufacturing quality influence bearing life."

While NES designs, manufactures and, on occasion, sells these test rigs, the common practice is for OEMs to simply have their testing done at the NES facility on an NES rig designed and built to the OEM's needs. After all,



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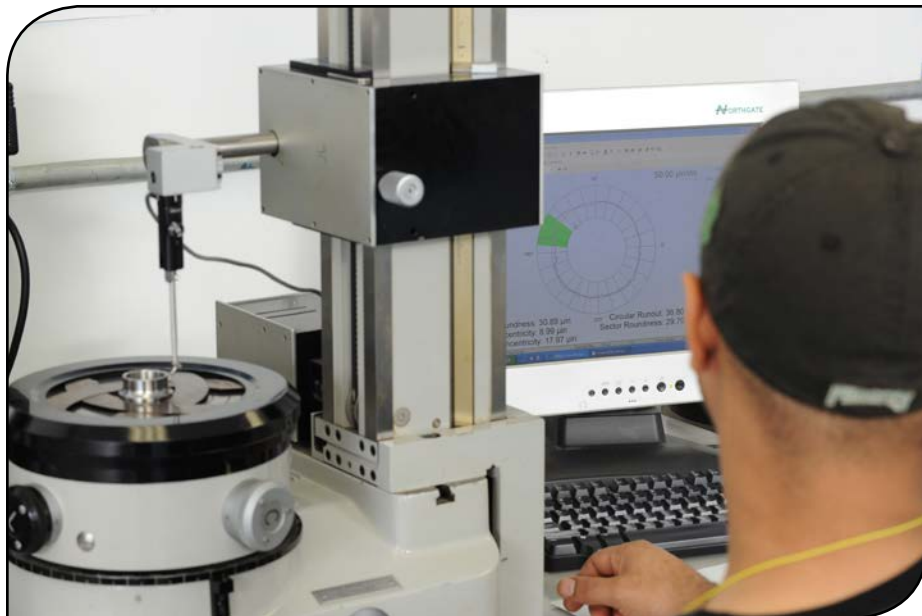
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even if they bought a rig outright and set it up in their plant, chances are there would be no one there capable of knowing how to use it to optimal advantage.

As one would reasonably expect, the quality and inspection program at NES is “as good as it gets,” says Napoleon. “The SQI program is very intense; its background comes from the aerospace industry. The FAA has a reverse-engineering process that allows one to become approved as a supplier for a particular application when you were not originally part of the type-certification testing process. This process is called “parts manufacturing approval (PMA).” If you reverse-engineer the type-certified product—in this case a bearing—and show the FAA that you have done your due diligence through inspection and, possibly, testing, they will grant you a PMA. Early on, NES was involved in performing the reverse-engineering of bearings for those interested in achieving PMA approval, a process that has been in place for over 40 years. It’s a proactive approach to qualifying new sources of supply. Concurrent with that work, we were performing a tremendous amount of failure analysis for industrial OEMs who, as it turned out, had recently changed bearing suppliers. The industrial OEMs were engaged in a *reactive* approach to bearing qualification while the aerospace industry was *proactive*. So I created an industrial re-



verse-engineering program for OEMs and called it (SQI).”

Most agree that bearing standards are not as internationally well-defined or stringently enforced as needed. Accepting that premise, how does that affect various manufacturing test rigs (for bearings, in this case) and the efficacy of testing done for various—many safety intensive—applications?

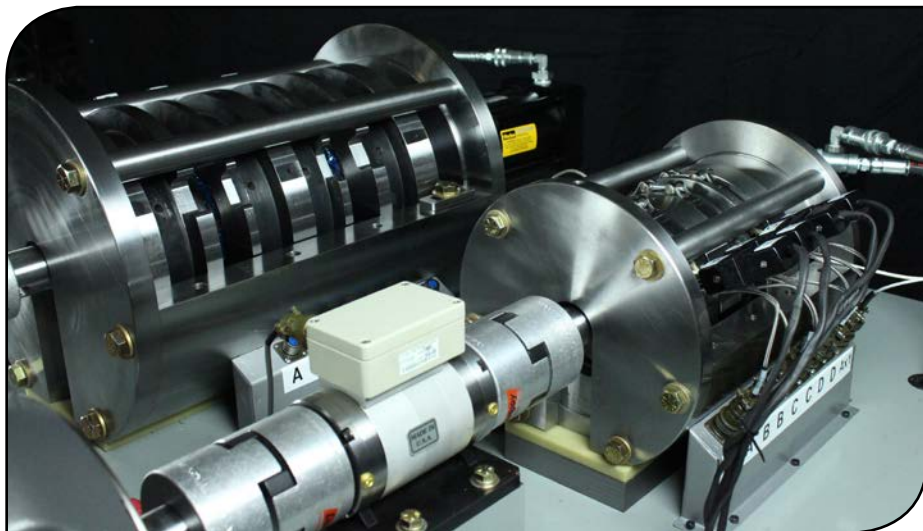
“This is a great question and likely plays a fundamental role in the development of NES’ products and services. Much of bearing design is not controlled by international standards and is left up to the individual manufacturer. As a result, this leaves the OEM with considerable risk when qualifying new bearing suppliers. First, the OEM needs to take ownership of the design

of the bearing in their application. Secondly, as mentioned, there are few standards for testing of bearings. This isn’t necessarily bad since it gives a lot of freedom to develop your own testing protocol for establishing acceptability of the product. We have found that most industrial OEMs need support in developing that protocol. That is where we come in with the SQI and the testing programs and test rigs.

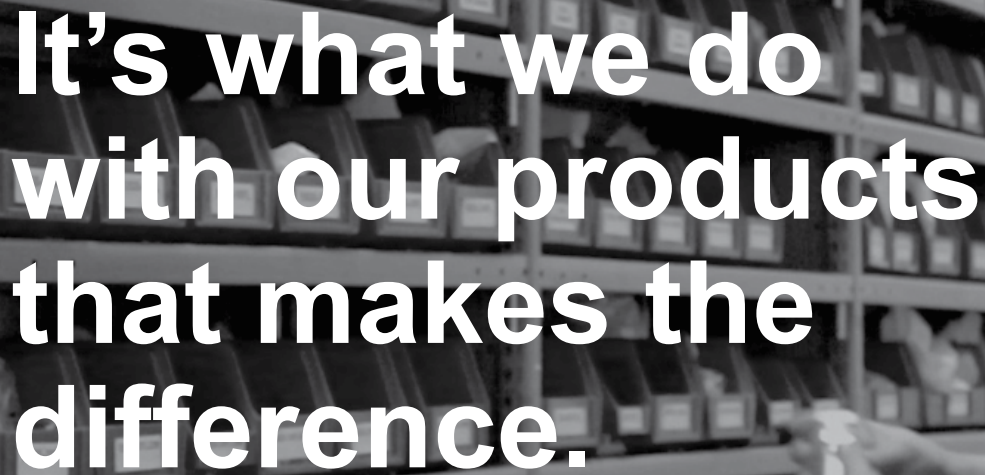
“To some degree we have become the UL of bearing testing. The first thing that we always ask an OEM is what their intention for testing is. Once we clearly understand what they want to achieve and why they want to engage in some sort of testing program, then we marry that with the protocols that we have set up with one or more of our test rigs.” **PTE**

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The Efficient Drive System

Coupling Manufacturers Discuss Trends, Challenges and Future Outlook

Matthew Jaster, Senior Editor

It's a fact that drive systems wouldn't function properly or efficiently without couplings.

They quietly go about their business of transferring motion from one drive element to the next. In the PT market today, couplings have the unique challenge of satisfying a variety of customer needs including tighter tolerances, higher speeds and a more versatile selection process.

"Many of the advancements have been in manufacturing technology leading to a more reliable and consistent product," says William Hewitson, vice president of operations, Ruland Manufacturing Co. Inc. "As the manufacturing equipment has gotten better, we have been able to make changes, such as maintaining tighter tolerances, more precise geometry of features, improved balancing for higher speeds, and better finishes for longer life of wear components. Maintaining tight tolerances is important, as most industries are moving towards higher precision servo-driven systems with less misalignment and higher speeds. Fit is critical for couplings, as it helps prevent slippage and failure during operation. Balanced designs for our flexible couplings as a standard plays a key role in system performance, as balancing reduces vibration and allows for higher RPM capabilities."

"Our customers are placing a greater reliance on Lovejoy to provide expertise in the selection of the proper type of coupling for the application," says Paul Petruska, executive director of strategy and business development at Lovejoy. "In some instances we have become an extension of the customer's engineering department and are routinely consulted during the design phase. This gives the ability to not only ensure that the coupling—but the entire system—will perform at optimal



levels while identifying and eliminating any major issues before the unit is manufactured."

"One of the key advancements in coupling technology in which R+W played a role was the development of extremely compact, lightweight, ball-detent safety couplings in 2010," says Andy Lechner, sales and marketing manager at R+W. "On average the couplings have a 50 percent higher torque capacity and 50 percent lower mass and moment of inertia for a given size than previous designs. This becomes important as some designers move away from using mechanical torque limiters, opting instead to rely on electronic current limitation in the drive for overload protection. In situations where this is ultimately determined to have been a mistake, there is often very limited space for the integration of mechanical overload protection. So the small size is sometimes critical.

The light weight and low inertia are also advantageous to people developing smaller, faster, and more energy-ef-

ficient devices from the manufacturing world and beyond, into flight systems, military robotics, and many other high tech devices," Lechner adds.

"In the last three to five years, some of the biggest industry improvements have come as the result of the consolidation in the industry. Today more customers have easier access to service and support of a broader range of products locally than they did five or 10 years ago," says Mark O'Neil, director of engineering at Altra Couplings.

Challenges Ahead

With technology rapidly changing and price always a factor, many coupling manufacturers have to aggressively seek out new industries and raise the bar on the quality of their own products. Additional challenges include redesign, higher speeds and changing the perception of couplings in the PT market.

"There are several advancements in electrical generator technology that are being developed that will require very

high-speed reliable couplings. These new applications are still many years away from large-scale production, but they offer some of the most challenging opportunities for coupling design," O'Neil says. "On the other end of the spectrum is the constant cost pressure of a global market. Engineering and production are continuously challenged to provide quality products that meet the customers' requirements at a competitive price. We are continuously working on new materials to provide our customers with longer life, higher torque ratings and increased misalignment capabilities to allow us to differentiate ourselves in the market."

"In many industries the need for higher speeds is increasing, with demands placed on coupling manufacturers for a wider variety of precision flexible couplings capable of running smoothly at higher rotational velocities. Coupling engineers are challenged with evaluating and redesigning existing products for the types of loads that develop at speeds into the tens of thousands or revolutions per minute," Lechner says.

"One of the biggest challenges is overcoming the perception of the cou-

pling as a low-cost component by both engineering and purchasing," Hewitson says. "Couplings are often the last component to be designed into a system, as they have a low relative cost when compared with other components. Customers expect that there is a standard coupling that will fit their design when this is often not the case. For example, couplings with minor dimensional differences in length or outside diameter can have a significantly higher cost than a standard part. As a manufacturer, we work with customers during the design process as much as possible to ensure they are using a standard part that will function as required and keep cost to a minimum. There is also a significant amount of variation in sizes, styles, and materials of couplings that are offered. Customers expect that they can get our products quickly no matter where they are in the world."

"Our greatest challenge is educating the user groups on the technical features and maintenance of different types of couplings. To increase user knowledge, Lovejoy has teamed up with VibrAlign, a leading supplier of laser alignment systems, to provide a coupling alignment and maintenance practices seminar, free to the user.

This allows the user to learn the latest tips and tricks while having the alignment and coupling experts answer any questions they have," Petruska says.

Stock vs. Custom

Like other power transmission components, coupling manufacturers need to provide a balance of stock and

custom products. Custom couplings provide better results for high performance applications, but a shelf full of stock products is equally important.

"Approximately 40 percent of the products delivered by R+W are custom made in some way. This obviously benefits engineers who are looking for the optimal solution from a technical standpoint. But off-the-shelf product is also very important to R+W to help keep cost and lead time to a minimum. This balance helps keep R+W agile, as the focus on short lead times for high performance products also puts the company in a position to deliver some special products more quickly. Over the past few years, R+W has actually been increasing its inventory, especially in the United States, tripling the number of unique SKUs in stock over the past two years."

"Lovejoy is unique in that we pride ourselves in offering a deep catalog of standard products while having the ability to provide custom highly engineered solutions. This gives us the ability to quickly determine if an off-the-shelf solution will meet a customer's application or if a custom designed product will provide additional benefits. For instance, one recent power generation application enabled Lovejoy to provide a mixture of custom and off-the-shelf products to meet the user's needs without having the long delivery timeline typically associated with a custom engineered solution," Petruska says.

"We are shipping special couplings on a daily basis," Hewitson says. "While there has been a push to standardize as many products as we can, there are always variations that customers want. Commonly they include customizations to finishes, bore sizes or tolerances, materials, performance, and hardware. Manufacturing all of our products ourselves gives us the ability to accommodate a wide variety of specials with short lead times."

"Altra Couplings provides a full range of couplings solutions from off-the-shelf products to very highly-engineered products. A significant part of our business involves taking standard, off-the-shelf products and modify-



Ruland rigid couplings do not introduce misalignment into the system, which is vital in servo driven applications.



The Torsiflex coupling from Altra is designed for process pump applications.

ing them to meet specific customer requirements. One of the advantages of our wide range of product offering is that a customer can build an entire plant with couplings from one company. Whether it's a critical process compressor running at 15,000 rpm or a fractional horsepower pump, all needs can be met with one supplier with established pricing," says O'Neil.

Customer Feedback

Faster lead times seem to be top of the list when it comes to customer demands, followed by technical support, larger inventories and longer life. "Customers are generally looking for the coupling that best fits their application parameters," Hewitson says. "This could be bore sizes, coupling dimensions, misalignment capabilities, maximum speed, or torque. It is important that all this information can easily be found on the website with an associated part number. Being able to compare different parameters between product lines is also a critical part of coupling selection. We have customized our website (www.ruland.com) to make this as easy as possible.

"Additionally, customers look for other supporting activities such as technical support, inventory, multiple coupling styles, configurations, and CAD models. In the last five years the web has made it easier for us to address all of these needs in one place. For example, we have added over 5,000 new coupling configurations to the website including keyed bellows and disc couplings as well as beam, bellows, and disc couplings with inch to metric bore combinations. (Hardcopy) catalogs could not have effectively de-

livered this information to customers. This has also forced us to be more flexible in manufacturing and to keep more WIP inventory that can be made to order on short notice," Hewitson says.

"Our customers are looking for longer life from couplings to reduce their downtime. They are looking for shorter delivery to reduce their inventory costs. They are looking for greater misalignment capability to reduce the time to install the equipment. They are also looking for more power density: smaller, lighter couplings that transmit more torque with less impact on the drive and driven equipment," O'Neil adds.

"One need, which may go without saying, is for the product to be more readily available. Not only are engineers required to develop products and bring them to market faster, but the tendency to reduce inventories across the supply chain has not gone away in our industry either, making short lead times ever more critical. As new equipment does continue to get smaller, faster and more efficient, the need for compact, backlash-free couplings are also increasing. Maintenance is another key issue, especially in larger couplings, which require periodic lubrication or replacement of flexible elements. Plant managers and maintenance professionals in all industries are increasingly looking for fatigue resistant flexible couplings which require zero maintenance," Lechner adds.

Future Considerations

Couplings will continue to get more compact, with efforts to make them

more easily configured for quick delivery. But what else will be contributing factors to the success of coupling manufacturers in the near future?

"For small, low performance, and standard couplings, marketing automation and online sales continue to be the big push. For high performance couplings, configurable CAD and sizing apps are also important, but the human interaction will have to remain in many cases. Technical service and response times to engineering inquiries will also have to get shorter in those instances. As the industry evolves, many companies will focus exclusively on streamlining the commercial aspects of their businesses, while some will also be increasing their technical resources and capabilities," Lechner says.

"The coupling industry will continue to evolve with service as a major selection factor. Service is evolving from just producing a coupling to fully supporting the customer in the engineering, manufacturing and service phases of the equipment. We have created a series of tools, from our coupling selector app to placing our catalog of couplings into a searchable on-line database to enable the customer to quickly access information," Petruska says.

"The coupling industry has seen a significant amount of consolidation in the last five years, and we would expect to see continued movement in that direction. Additionally, we would expect to see continued global expansion of those established companies into the non-traditional manufacturing countries," O'Neil says.



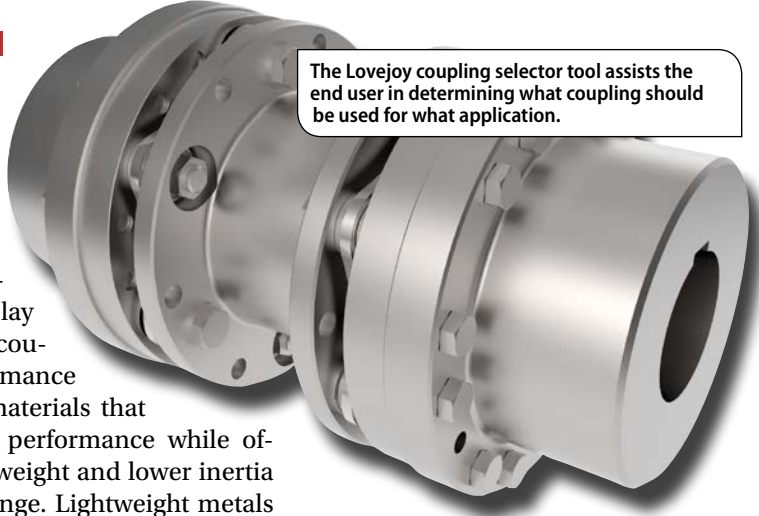
R+W's Survivor high performance disc pack couplings are intended for demanding industrial power transmission applications.

“Materials are one of the biggest development areas for couplings. They play a key role in coupling performance and finding materials that can maintain performance while offering lighter weight and lower inertia is a big challenge. Lightweight metals such as titanium and high strength plastics may be suitable alternatives to aluminum, steel, and stainless steel commonly used today. Mechanical automation using servo driven systems is becoming more prevalent in industries such as oil and gas and aerospace where the use of these materials is common. The high speeds, harsh environments, and high temperatures found in these industries has traditionally limited coupling selection to disc, bellows, or zero-backlash jaw couplings. As the material types advance there is opportunity to increase the performance characteristics of these couplings, while also allowing more forgiving couplings such as oldham and beam to be used.

What about 3-D printing technology for couplings? It’s already in play so to speak.

“Additive manufacturing, such as 3-D printing, will give us the ability to produce designs that have not been practical to machine in traditional ways. This also has the potential for us to create coupling designs that have not been imagined yet, which is the definition of game changing,” Hewitson says. “We are already beginning to use rapid prototyping as a way to test proof of concepts on experimental couplings and see this developing into custom production type couplings.”

PTE



The Lovejoy coupling selector tool assists the end user in determining what coupling should be used for what application.

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

Handy Online Resources



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

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

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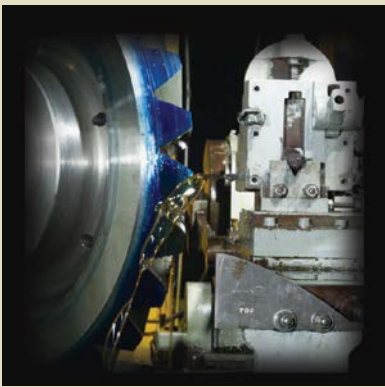
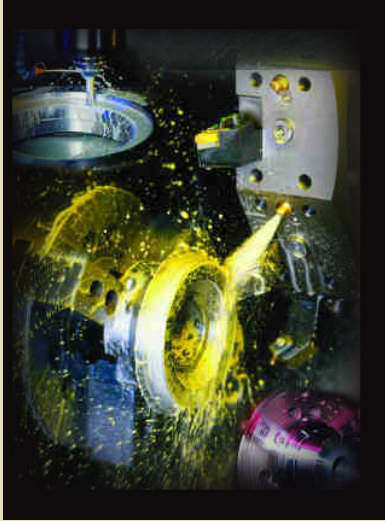
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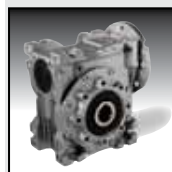
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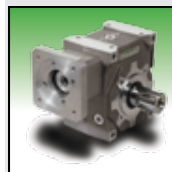
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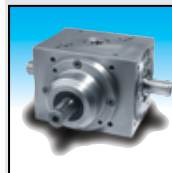
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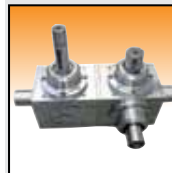
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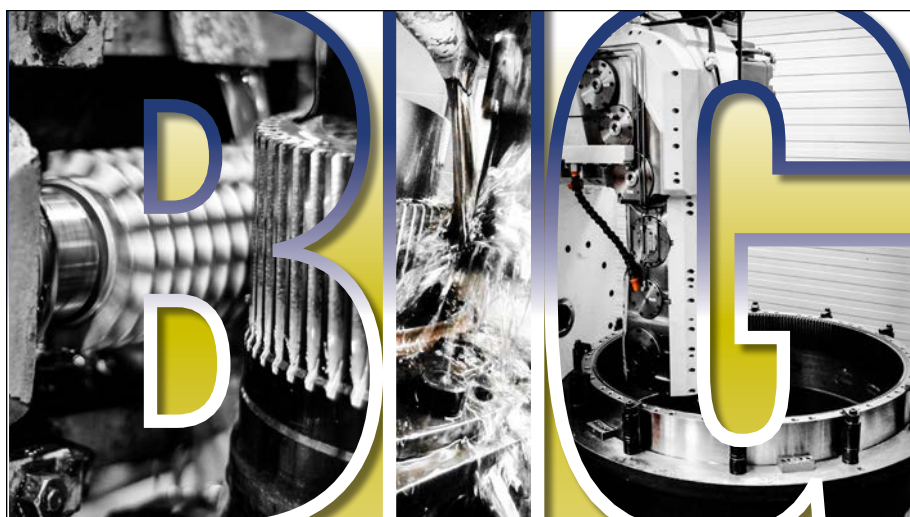
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Taiwan United Gear Co., Ltd.
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Ronson Gears Pty. Ltd
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 www.seweurodrive.com

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SIPCO-MLS

SKF USA Inc.
 890 FORTY FOOT RD.
 LANSDALE PA 19446
 Phone: (267) 436-6000
 www.skf.com

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P3

SPN Schwaben Praezision
 SSJ Italy
 ST Gear & Machine LLC
 STD Precision Gear and Instrument
 Sallex Machine Tools
 Sam Gears India Pvt.Ltd
 Schaeffler Group USA Inc.

Schafer Industries
 4701 NIMTZ PARKWAY
 SOUTH BEND, IN 46628-6151
 Phone: 574-234-4116
 Fax: 574-239-2158
 pshah@schafergear.com
 www.schafergear.com

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Seitz Corp.
 Shanthi Gears
 Shivam Autotech Ltd.
 Silvertech Industrial (H.K.) Ltd.
 Siti Spa Riduttori
 Sokhi Heli-Wom Gears Pvt. Ltd.
 Somaschini North America LLC
 Sond Gears Pvt. Ltd.
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 Southern Gear & Machine Inc.
 Spencer Pettus
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P35,41,43,46

Suhner Manufacturing Corp.
 Sumitomo Machinery Corp. of America
 Supreme Gear Co.
 Suzhou Asia Pacific Metal Co., Ltd.
 T.E.A. Machine Components
 Taiwan Precision Gear Corp.
 Taiwan United Gear Co., Ltd.
 Team Industries
 Terog Manufacturing / Black Ace Parts
 The Timken Company
 Thermotech
 Toffac Ingranaggi S.p.A.
 Toledo Gearmotor A Bluffton Motor Works Company
 Tool Masters India
 Torque Transmission
 Transply Inc.
 Triumph Group
 Trojon Gear Inc.
 Tsubaki of Canada Limited
 Tsubakimoto Chain Co.
 U.S. Gear
 U.S. Tsubaki Power Transmission, LLC
 Unigear Industries
 United Gear and Assembly, Inc
 VCST LP
 VW Broaching Service Inc.
 Valley Gear & Machine Inc.
 Vancouver Gear Works
 Venture Products International
 Vision Quality Components, Inc
 Voith Turbo GmbH & Co. KG
 W.M. Berg
 WD Bearing America
 WMH Transmissions Ltd
 Wilson Machine Co. Ltd.
 Winzeler Gear
 Wyko - London & Overseas Supplies
 Xtek, Inc.
 Xuzhou BeiLai Engineering Machinery Co., Ltd
 Xuzhou Topware Slewing Bearings Co.,Ltd

Yager Gear Enterprise Co. Ltd.
 NO. 57, SHIGU LANE, GUOZHONG ROAD
 DALI DISTRICT
 TAICHUNG CITY 412
 TAIWAN
 Phone: +(886) 4-2407-6223
 Fax: +(886) 4-2407-6218
 sa02@yagergear.com
 www.yagergear.com

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ZZN Transmission Plant
 Zero-Max

INDUSTRIAL HARDWARE AND MACHINE PARTS

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Advanced Antivibration Components - AAC
All Metric Small Parts (aMsp)
Allied-Locke Industries
American Plastics Depot
Blaney Gears Ltd.
Daemar Inc.
Delta Gear Company
EDT Industrial Resources, Inc.
EIC Industry Group
GMT Rubber-Metal-Technic
Gear Master Inc.
Hi-Grade Inc.
Houston Pump and Gear
J.W. Winco, Inc.

Motion Industries

1605 ALTON RD.
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Fax: (205) 957-5290
www.motionindustries.com

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Netshape Technologies, Inc.
Nordex Inc.
Powermach Import & Export Co. Ltd.
Premier Udyog
SKG Enterprises
Sterling Instrument

Stock Drive Products

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W.M. Berg

LINEAR MOTION DEVICES

ABB Group
AGI Automation Components
AISCO Inc./ Texas UJoints
AST Bearings
Accent Bearings Co. Inc.
Advanced Control Systems Corporation
Aerotech Inc.
Amacoil, Inc.
American Roller Screw
Ametek Precision Motion Control
Ametric / American Metric Corporation

Andantex USA Inc.

1705 VALLEY RD.
WANAMASSA, NJ 07712
Phone: (800) 713-6170
Fax: (732) 493-2949
info@andantex.com
www.andantex.com

SEE OUR AD
P19

Applimotion

Area Distributors Inc.
Atlanta Drive Systems Inc.
BDI - Bearing Distributors Inc.

Baldor Electric Company

5711 R.S. BOREHAM, JR. ST.
P.O. BOX 2400
FORT SMITH, AR 72901
Phone: (479) 646-4711
Fax: (479) 648-5792
www.baldor.com

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Beaver Aerospace and Defense Inc.
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Bishop-Wisecarver Corp.
Bison Gear and Engineering Corp.
Bosch Rexroth USA
CGI, Inc.

CUI Inc
Certified Reducer Rebuilders Inc.
Clarke Engineering Inc. (Clarke Gear Co.)
Custom Gear & Machine Inc.
Custom Sensors & Technologies (CST)
DN Sales Australia
Dalton Bearing Service, Inc.
Danaher Motion
Davall Gears Ltd.
David Brown Gear Systems Ltd.
Del-Tron Precision Inc.

DieQua Corp.

180 COVINGTON DRIVE
BLOOMINGDALE, IL 60108
Phone: (630) 980-1133
Fax: (630) 980-1232
info@diequa.com
www.diequa.com

SEE OUR AD
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Discovery Technology International, Inc.
Drive Lines Technologies Ltd.
Duff-Norton
Dunkermotoren USA Inc.
Durabond Slides
Dynamic Structures and Materials, LLC
Dynex/Rivett Inc.
EDT Industrial Resources, Inc.
Elmrad Engineering Co. Pvt. Ltd.
Exlar Corporation
FMC Engineering
Festo Corporation

Forest City Gear Co.

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Fax: (815) 623-6620
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www.fcgear.com

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Gilman Precision
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Halifax Rack & Screw Cutting Co. Ltd.
Hallmark Industries Inc.
Haydon Kerk Motion Solutions, Inc.
Houston Pump and Gear
IAI America, Inc.
IBT, Inc.

IDC-USA

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ISC Companies
Industrial Clutch Parts Ltd.
Intech PowerCore Corporation
Intellidrives, Inc
International Distribution Alliance, Inc.
InvenSense
K+S Services
Lee Linear
Lenze Americas Corporation
Mavilor Motors, S.a.
Micromo
Midwest Motion Products
Mitsubishi Electric Automation, Inc.
Modern Linear Inc.
Moog Components Group

Motion Industries

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Fax: (205) 957-5290
www.motionindustries.com

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Nexen Group Inc
Nook Industries, Inc.
Nordex Inc.

North American Clutch Corp. (NORAM)
NovaTorque, Inc.
Novotec Argentina SRL
Ondrives Ltd
Ormec
Orttech
PI (Physik Instrumente) L.P. Piezo Actuator Nano
PIC Design
PUH Sprzet-Kop Rajmund Krakowski
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Precision Screw Thread
Precision Spindle & Accessories Inc.
Precision Technologies Group (PTG) Ltd.
Purvis Industries
Quality Bearings & Components - QBC
Rex Engineering Corp.
Rexnord - Process and Motion Control
Rockford Linear Motion, LLC
Rockwell Automation
SIPCO-MLS

SKF USA Inc.

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SPN Schwaben Praezision
Schneeberger Inc.
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Servomech US
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T.E.A. Machine Components
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Technico
Techno-Isel
Tecnotion BV
TelcoMotion
The Precision Alliance
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Tolomatic, Inc.
Tsubakimoto Chain Co.
U.S. Tsubaki Power Transmission, LLC
Ultra Motion
VL Motion Systems Inc.
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WEG
WMH Transmissions Ltd
Warner Linear
Whittet-Higgins Company
Wittenstein (formerly alpha gear drives)
Wyko - London & Overseas Supplies
Yaskawa America, Inc. - Drives & Motion Divisi
Zaber Technologies
Zero-Max

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Brighton Laboratories
Cortec Corporation
 Kluber Lubrication North America L.P.
 Lubrication Engineers

Lubriplate Lubricants Co.
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MOTORS

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BDI - Bearing Distributors Inc.

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 5711 R.S. BOREHAM, JR. ST.
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Festo Corporation
GMB Associates
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JVL Industri Elektronik A/S
K+S Services
Kollmorgen

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 CANADA
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 Fax: (905) 629-2852
ptsales@lafertna.com
www.lafertna.com

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MT Tool & Manufacturing
Marathon Electric Motors
Mark Elektriks
Master Power Transmission
Mavilor Motors, S.a.
Maxon Precision Motors Inc
Micromo
Midwest Motion Products
Mini Motor USA
Mitsubishi Electric Automation, Inc.
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Norwin Electronics Limited

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Novotec Argentina SRL
Onvio LLC
Ormec
Overly Haultz Motor Base Co.
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Parker Hannifin Electromechanical Automation Divis
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Phytron, Inc.
Popular Mechanical Works
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Power Electric
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Rockwell Automation

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www.seweurodrive.com

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Star Gears
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TSS Rotterdam B.V.
TVT America, Inc.
Taiwan Precision Gear Corp.
Tapeswitch Corporation
Techno-Isel
Tecnotion BV
Teco Westinghouse
Tef - Cap Industries
TelcoMotion
Thomson
Tolomatic, Inc.
Transmotec AB
Transply Inc.
U.S. Tsubaki Power Transmission, LLC
V&T Technologies Co., Ltd.
VL Motion Systems Inc.
Vision Quality Components, Inc
WEG
Wittenstein (formerly alpha gear drives)
Worldwide Electric Corp.
Wyko - London & Overseas Supplies
Yaskawa America, Inc. - Drives & Motion Divisi
Yilmaz Reduktor
Zaber Technologies
Zero-Max

RESOURCES

AGMA
AMT - The Association For Manufacturing Technology
American Bearing Manufacturers Association
Bearing Specialists Association (BSA)
CTI (Car Training Institute)
Hannover Fairs USA

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www.smalley.com

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DOWNERS GROVE, IL 60515
Phone: (312) 235-6521
Brian@Langenberg-LLC.com
www.langenberg-llc.com

SEE OUR AD
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Advanced Test & Automation Inc.
Akron Gear and Engineering
Allied Motion

Area Distributors Inc. Automation Direct

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www.automationdirect.com

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MPIF (Metal Powder Industries Federation)
Mack Brooks Exhibitions Ltd.
National Fluid Power Association (NFPA)
PTDA - Power Transmission Distributors Association
Power-Motion Technology Representatives Association
SMMA - The Motor and Motion Association
SaSad
Society of Tribologists and Lubrication Engineers
THORS LLC
Webcom Communications Corp.

SEALS

Accent Bearings Co. Inc.
Acorn Industrial Services
All Metric Small Parts (aMsp)
Ametric / American Metric Corporation
Apache Inc. (Apache | Trico)
Area Distributors Inc.
BDI - Bearing Distributors Inc.
Bearing Service Company
Best Parts Online
Certified Reducer Rebuilders Inc.
Core Supply LLC
Cotta Transmission Company
Daemar Inc.
Dalton Bearing Service, Inc.
Darbar Belting
EDT Industrial Resources, Inc.
Fey Laminar Rings - North America
GMN Bearing Usa, Ltd.
Houston Pump and Gear
IBT, Inc

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www.IDC-USA.com

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BEI Industrial Encoders
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Bison Gear and Engineering Corp.
Bonfiglioli USA
Bosch Rexroth USA
CUI Inc
Conroll Corporation
Conveyor Components Company
Cotta Transmission Company
Custom Sensors & Technologies (CST)
Dalton Bearing Service, Inc.
Drive Lines Technologies Ltd.
Duff-Norton
Dunkermotoren USA Inc.
Electronic Machine Parts
FSI Technologies Inc.
Fagor Automation
Festo Corporation
Fife Corporation
GKN Land Systems
GMB Associates
Great Northern Products Inc.
HBM
HEIDENHAIN Corporation
HPB Motion Control Co. Ltd.
Harmonic Drive LLC
IBT, Inc

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MROSupply
Metallized Carbon Corporation

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Moventas Ltd.
OEM International Inc.
Peer Bearing Company
Purvis Industries
Rowland Company, The
Rubena A.S.

SKF USA Inc.
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Phone: (267) 436-6000
www.skf.com

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InvenSense
JVL Industri Elektronik A/S
K+S Services
KTR Corp.
Kavlico Corporation
Magnetic Sensors Corporation
Magtrol, Inc.
Marshall Wolf Automation Inc.
Maxon Precision Motors Inc
Mayr Corp.
Measurement Specialties
Microner Inc.
Midwest Motion Products

Nexen Group Inc
Nidec-Avtron Automation
Nook Industries, Inc.
Norwin Electronics Limited
Novotec Argentina SRL
PI (Physik Instrumente) L.P. Piezo Actuator Nano
PUH Sprzet-Kop Rajmund Krakowski
Pepperl+Fuchs
Placid Industries
Portescap
Potomac Electric
Power Electric

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Fax: (631) 694-4016
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www.precipart.com

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Promess Inc.
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Rdf Corporation
Redex Andantex
RoMaDyn - Rotating Machinery Engineering Services
Rockwell Automation
Scancon Encoders
Schenck Trebel Corporation
Schneeberger Inc.
Schneider Electric Sensor Developments Inc
Sensor Products Inc.
Sensor Technology Ltd.
Source Engineering Inc.
Stafford Manufacturing Corp.
Stellar Technology Inc.
Sterling Instrument

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Tapeswitch Corporation
Techno-Isel
Tef - Cap Industries
Transply Inc.
Tsubakimoto Chain Co.
U.S. Tsubaki Power Transmission, LLC
Warner Electric
Wyko - London & Overseas Supplies
Xtek, Inc.

SOFTWARE

Dontyne Systems
Drive Systems Technology Inc.

Excel Gear, Inc.
11865 MAIN STREET
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Phone: (815) 623-3414
Fax: (815) 623-3314
chinn@excelgear.com
www.excelgear.com

SEE OUR AD
P12

GWJ Technology GmbH
KISSsoft, USA, LLC
MSC Software Corporation
Romax Technology Limited
Smart Manufacturing Technology - SMT
Universal Technical Systems, Inc. (UTS)

A. Fischer Phase Drives
4615 W. PRIME PARKWAY
MCHENRY, IL 60050-7037
Phone: (815) 759-6928
Fax: (815) 363-1641
info@afischerphasedrives.com
www.afischerphasedrives.com

AA Gear & Manufacturing
1045 DURANT DR.
HOWELL, MI 48843
Phone: (517) 552-3100
Fax: (517) 552-6220
info@aa-gear.com
www.aa-gear.com

ABA-PGT, Inc.
10 GEAR DR.
MANCHESTER, CT 06042
Phone: (860) 649-4591
www.abapgt.com

ABB Group
1250 BROWN RD.
AUBURN HILLS, MI 48326
Phone: (248) 391-9000
www.abb.com

Abbott Ball Company
19 RAILROAD PLACE
P.O. BOX 330100
WEST HARTFORD, CT 06133
Phone: (860) 236-5901
Fax: (860) 233-1069
cstevenson@abbottball.com
www.abbottball.com

ABL Products Incorporated
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abl@ablproducts.com
www.ablproducts.com

ABT Bearing
345 PRODUCTION DRIVE
SOUTH ELGIN, IL 60177
Phone: (800) 931-1860
Fax: (847) 931-9411
sales@abtbearing.com
www.abtbearing.com

Accent Bearings Co. Inc.
367-G S. ROHLWING ROAD
ADDISON, IL 60101
Phone: (630) 916-1930
Fax: (630) 916-7740
accentbrg@aol.com
www.accentbearing.com

Accurate Gear and Machine, Inc.
2864 BURTON AVE.
WATERLOO, IA 50703
Phone: (319) 233-1997
Fax: (319) 233-7677
sales@accurategear.com
accurategear.com

Ace World Companies
10200 JACKSBORO HIGHWAY
FORT WORTH, TX 76135
Phone: (817) 237-7700
Fax: (817) 237-2777
camron@aceworldcompanies.com
www.aceworldcompanies.com

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Phone: +(55) 11-3743-3251
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Acionac Indústria E Comércio Ltda.
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BRAZIL
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www.acionac.com.br

Acme Gear Co.
130 WEST FOREST AVE.
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www.acmegear.com

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EDEN PRAIRIE, MN 55344
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DUBUQUE, IA 52002
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Fax: (563) 583-8048
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Fax: (516) 328-3365
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PEMBROKE, MA 02359
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MILTON ONTARIO L9T 5A1
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LONGMONT, CO 80501
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www.aerocom-industries.com

Aerotech Inc.
101 ZETA DRIVE
PITTSBURGH, PA 15238-2897
Phone: (412) 963-7470
Fax: (412) 963-7459
sales@aerotech.com
www.aerotech.com

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171 SPRING HILL RD.
TRUMBULL, CT 06611
Phone: (203) 459-8345
Fax: (203) 459-5943
info@agi-automation.com
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ALEXANDRIA, VA 22314-1587
Phone: (703) 684-0211
Fax: (703) 684-0242
webmaster@agma.org
www.agma.org

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E-3, INDUSTRIAL ESTATE
KOTA - 324007 RAJASTHAN 324007
INDIA
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Fax: +(91) 744-2360835
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www.agroengineers.com

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Fax: (817) 335-7922
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NEW HYDE PARK, NY 11040
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Fax: (516) 302-0153
amspsupport@amsp.biz
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Allen Gears Ltd.
ATLAS WORKS
STATION ROAD
PERSHORE WORCESTERSHIRE WR10 2BZ
UNITED KINGDOM
Phone: +(44) 1386-552-211
Fax: +(44) 1386-554-491
sales@allengears.com
www.allengears.com

Allied Gear Co.
4901 W. ARTHINGTON ST.
CHICAGO, IL 60644
Phone: (773) 287-8742
Fax: (773) 287-4720
nt350@thealliedgearco.com
www.thealliedgearco.com

Allied Motion
455 COMMERCE DRIVE, STE 5
AMHERST, NY 14228
Phone: (716) 242-7535
inquiry@alliedmotion.com
www.alliedmotion.com

Allied Specialty Precision Inc.
P.O. BOX 543
815 E. LOWELL AVE.
MISHAWAKA, IN 46546
Phone: (574) 255-4718
Fax: (574) 255-4173
larry.delater@aspi-nc.com
www.aspi-nc.com

Allied-Locke Industries
1088 CORREGIDOR DR.
GREEN RIVER INDUSTRIAL PARK
DIXON, IL 61021
Phone: (815) 288-1471
Fax: (815) 288-7945
info@alliedlocke.com
www.alliedlocke.com

Amacoil, Inc.
PO BOX 2228
2100 BRIDGEWATER ROAD
ASTON, PA 19014
Phone: (610) 485-8300
Fax: (610) 485-2357
amacoil@amacoil.com
www.amacoil.com

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TAJAPUR MOMINWAD, JAMALPUR,
AHMEDABAD - 380001 GUJARAT
INDIA
Phone: +(91) 79-25399491
Fax: +(91) 79-25395971
info@amantransbelt.com
www.amantransbelt.com

Amec Industry
1805 E. FRANCIS ST.
ONTARIO, CA 91761
Phone: (888) 325-1888
Fax: (909) 923-5080
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American Bearing Manufacturers Association
2025 M STREET, NW SUITE 800
WASHINGTON, DC 20036
Phone: (202) 367-1155
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www.americanbearings.org

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88 HUBBARD STREET
WINSTED, CT 06098
Phone: (860) 379-7043
Fax: (860) 379-7063
info@americancollars.com
www.americancollars.com

American Gear & Engineering, Inc.
38200 ABRUZZI DR.
WESTLAND, MI 48185
Phone: (734) 595-6400
Fax: (734) 595-0149
jeff@americangear.net
americangear.net

American Gear, Inc.
P.O. BOX 156
910 SWANSON DR.
PROPHETSTOWN, IL 61277
Phone: (815) 537-5111
Fax: (815) 537-2871
info@americangearinc.com
www.americangearinc.com

American Plastics Depot
10194 SW CONCHO COURT
TUALATIN, OR 97062-9570
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www.americanplasticsdepot.com

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SUITE 150
CHARLOTTE, NC 28210
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www.about-ars.com

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PITTSFORD, NY 14534
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Fax: (585) 292-5525
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www.americanswiss.com

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ERIE, PA 16502
Phone: (814) 480-5000
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1680 CORNELL RD.
GREEN BAY, WI 54313
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Ametek Precision Motion Control
100 EAST ERIE STREET
KENT, OH 44240
Phone: (330) 673-3452
info@ametekpmc.com
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52 METRIC ROAD
LAURENS, SC 29360
Phone: (864) 876-2011
Fax: (864) 876-2630
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AMT - The Association For Manufacturing Technology
7901 WESTPARK DRIVE
MCLEAN, VA 22102-4206
Phone: (703) 893-2900
Fax: (703) 893-1151
amt@amtonline.org
www.amtonline.org

Anaheim Automation, Inc.
910 EAST ORANGEFAIR LANE
ANAHEIM, CA 92801
Phone: (714) 992-6990
Fax: (714) 992-0471
sales@anaheimautomation.com
www.anaheimautomation.com

Ancon Gear & Instrument Corp.
29 SEABRO AVE.
AMITYVILLE, NY 11701
Phone: (631) 694-5255
Fax: (631) 694-5056
info@ancongear.com
www.ancongear.com

Andantex USA Inc.
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INDIA
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Fax: +(91) 265-2781810
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www.annflex.com

Apache Inc. (Apache | Trico)
4805 BOWLING STREET SW
CEDAR RAPIDS, IA 52404
Phone: (866) 757-7816
Fax: (319) 365-2522
info@apache-inc.com
www.apache-inc.com

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Fax: (630) 599-3001
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apscorp.com

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HAUPPAUGE, NY 11788
Phone: (631) 582-8020
Fax: (631) 582-8038
mail@arcsystemsinc.com
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WOODSIDE, NY 11377
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Fax: (718) 626-0712
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areadist.com

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www.artec-machine.com

Ascent Precision Gear Corporation
12180 SE COUNTY ROAD 137
JASPER, FL 32052
Phone: (386) 792-3215
Fax: (386) 792-3216
sales@ascentgear.com
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Ashot Ashkelon Industries Ltd.
1 EZRA YESODI STREET
ASHKELON 78100
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Phone: +(972) 8-6721511
Fax: +(972) 8-6721711
yaron.gilboa@ashot.co.il
www.ashot.co.il

Ashutosh Power TransBelts Limited
707, HEMKOOT BUILDING,
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ASHRAM ROAD,
AHMEDABAD - 380009 GUJARAT
INDIA
Phone: +(91) 79-26580282
Fax: +(91) 79-26581238
info@aptbelts.com
www.aptbelts.com

ASI Technologies Inc.
209 PROGRESS DRIVE
MONTGOMERYVILLE, PA 18936
Phone: (215) 661-1002
Fax: (215) 661-1009
sales@asidrives.com
www.asidrives.com

AST Bearings
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MONTVILLE, NJ 07045-9299
Phone: (973) 335-2230
Fax: (973) 335-6987
inquiry@astbearings.com
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ATA Gears Ltd.
P.O. BOX 120
TAMPERE FIN-33101
FINLAND
Phone: +(358) 3287-0111
Fax: +(358) 3287-0249
postmaster@atagears.fi
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Atlanta Drive Systems Inc.
1775 ROUTE 34, UNIT D-10
FARMINGDALE, NJ 07727
Phone: (732) 282-0480
Fax: (732) 282-0450
info@atlantadrives.com
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Atlanta Gear Works, Inc
433 HIGHTOWER PARKWAY
DAWSONVILLE, GA 30534
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Fax: (706) 216-5052
sales@atlantagear.com
www.atlantagear.com

Automation Direct
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SHARON, TN 38255
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GERMANY
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www.bauergears.com

BC Gear Inc
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NORTH CHARLESTON, SC 29418
Phone: (843) 207-8700
Fax: (843) 207-1007
bcgear@aol.com
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143 ETHEL ROAD WEST
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CLEVELAND, OH 44125
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info@bdi-usa.com
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Bearing Service Company
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PITTSBURGH, PA 15238
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Fax: (412) 963-8005
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www.bearing-service.com

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www.bsahome.org

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2100 PACIFIC STREET
HAUPPAUGE, NY 11788
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Beaver Aerospace and Defense Inc.

11850 MAYFIELD
LIVONIA, MI 48150
Phone: (734) 853-5003
Fax: (734) 853-5043
info@beaver-online.com
www.beaver-online.com

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UL. GRAZYNSKIEGO 71
43-300 BIELSKU-BIALEJ
POLAND
Phone: +(48) 33-8126031
Fax: +(48) 33-8159363
marketing@befared.com.pl
www.befared.com.pl

BEI Industrial Encoders

7230 HOLLISTER AVE.
GOLETA, CA 93117
Phone: (800) 350-2727
Fax: 805-968-3154
contact@beisensors.com
www.beisensors.com

Beijing THC Limited

1-16 HUATENGGOUJI
2 DAJIAOTING ZHONGJIE
CHAOYANG
BEIJING 10024
CHINA
Phone: +(86) 10-8795-2546
Fax: +(86) 10-8795-2541
sales@beijingthc.com
www.beijingthc.com

Belcon Engineers P. Ltd.

A9 NEW SONAL INDL. ESTATE,
SAKI VIHAR ROAD,
MUMBAI - 400072
INDIA
Phone: +(91) 22-2857 53 18/ 19
Fax: +(91) 22-2857 5321
response@belconengineers.com
www.belconengineers.com

Belden Inc.

2500 BRAGA DRIVE
BROADVIEW, IL 60155
Phone: (708) 344-4600
Fax: (708) 344-0245
info@beldenuniversal.com
www.beldenuniversal.com

BelleFlex Technologies, LLC

706 ELJER WAY
FORD CITY, PA 16226
Phone: (724) 540-5053
Fax: (724) 540-5063
fbalina@belleflex.com
www.belleflex.com

BellowTech, LLC

1289 N. U.S. HIGHWAY 1, SUITE 1
ORMOND BEACH, FL 32174
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Fax: (386) 615-7973
bellow@bellowtech.com
www.bellowtech.com

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MINDEN, NV 89423-4114
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Fax: (775) 783-4650
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BUDAPEST 1145
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bervina@bervina.com
www.bervina.com

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17B SADARAMANGALA INDUSTRIAL AREA
WHITEFIELD ROAD
BANGALORE - 560048
INDIA
Phone: +(91) 80-28410312
Fax: +(91) 80-28410185
jamaigrp@vsnl.com
www.bevelgearsindia.com

Bharat Gears Ltd.

KAUSA SHIL, SHILPHATA, DISTRICT THANE
THANE - 400 612 MH
INDIA
Phone: +(91) 22-25352692
Fax: +(91) 22-25351651
info@bglindia.com
www.bharatgears.com

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DEWSBURY WEST YORKSHIRE WF13-1EH UK
UNITED KINGDOM
Phone: +(44) 1924460801
sales@bibbytransmissions.co.uk
www.bibbytransmissions.co.uk

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RINGBAAN NOORD 189
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NETHERLANDS
Phone: +(31) 13-5360025
Fax: +(31) 13-5435550
info@bierens.com
www.bierens.com

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2250 PERIMETER PARK DR., SUITE 120
MORRISVILLE, NC 27560
Phone: (919) 651-5465
Fax: (919) 465-0516
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4571 W. MACFARLANE
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Phone: (231) 334-4383
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sales@binsfeld.com
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3850, OH. AVE.
ST. CHARLES, IL 60174
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Fax: (630) 377-6777
info@bisongear.com
www.bisongear.com

Blaney Gears Ltd.

37 CARNARNEY RD.
AHOGHILL
BALLYMENA, CO ANTRIM BT42 2PJ
UNITED KINGDOM
Phone: +(44) 28 2587 2805
Fax: +(44) 28 2587 8784
info@blaneygears.com
www.blaneygears.com

Boca Bearing Company

1420 NEPTUNE DRIVE
SUITE A
BOYNTON BEACH, FL 33426
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Fax: (800) 409-9191
info@bocabearings.com
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201 NORTHFIELD ROAD
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Phone: (773) 478-3515
Fax: (773) 478-3232
info@bodine-electric.com
www.bodine-electric.com

Boneng Transmission (Suzhou) Co., Ltd.

NO.100 RUYUAN RD.
XIANGCHENG DISTRICT
SUZHOU 215121
CHINA
Phone: +(86) 512-6618 9922
Fax: +(86) 512-6618-9966
info@boneng.com
www.boneng.com

Boneng Transmission USA LLC

1670 ENTERPRISE PKWY.
TWINSBURG, OH 44087
Phone: (330) 907-1117
Fax: (330) 425-1519
america@boneng.com
www.boneng.com/en/index.asp

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VIA GIOVANNI XXIII, 7/A
40012 LIPPO DI CALDERARA BOLOGNA
ITALY
Phone: +(39) 051-6473-111
Fax: +(39) 051-6473-126
bonfiglioli@bonfiglioli.com
www.bonfiglioli.com

Bonfiglioli 3541 Hargrave Drive

HEBRON, KY 41048
Phone: (859) 334-3333
Fax: (859) 334-8888
www.Bonfiglioliusa.com

Bosch Rexroth 14001 South Lakes Drive

CHARLOTTE, NC 28273
Phone: (800) 739-7684
Fax: (704) 583-0523
info@boschrexroth-us.com
www.boschrexroth-us.com

Boston Gear

701 CARRIER DR.
CHARLOTTE, NC 28216
Phone: (704) 588-5610
Fax: (704) 588-7181
info@altramotion.com
www.bostongear.com

Bowman Hollis Mfg

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CHARLOTTE, NC 28208
Phone: (704) 374-1500
Fax: (704) 333-5520
sbroadwell@bowmanhollis.com
www.bowmanhollis.com

Bowmar LLC

8000 BLUFFTON ROAD
FORT WAYNE, IN 46809
Phone: (260) 747-3121
Fax: (260) 747-9601
jstephens@bowmarllc.com
www.bowmarllc.com

Brad Foote Gear Works, Inc

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861 CRANBERRY COURT
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www.davall.com

David Brown Gear Systems Ltd.

PARK ROAD
LOCKWOOD
HUDDERSFIELD YORKSHIRE HD4 5DD
UNITED KINGDOM
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Fax: +(44) 0-1484 465-501
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VADODARA - 390002 GUJARAT
INDIA
Phone: +(91) 265-2794341
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www.delroyd.com

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7580 MACDONALD ROAD
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CANADA
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Fax: (604) 940-1029
info@deltadynamics.com
www.deltadynamics.com

Delta Gear Company

345 SUN VALLEY CIRCLE
FENTON, MO 63026
Phone: (636) 343-0311
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sales@dgc-atc.com
www.dgc-atc.com

Delta Gear Inc.

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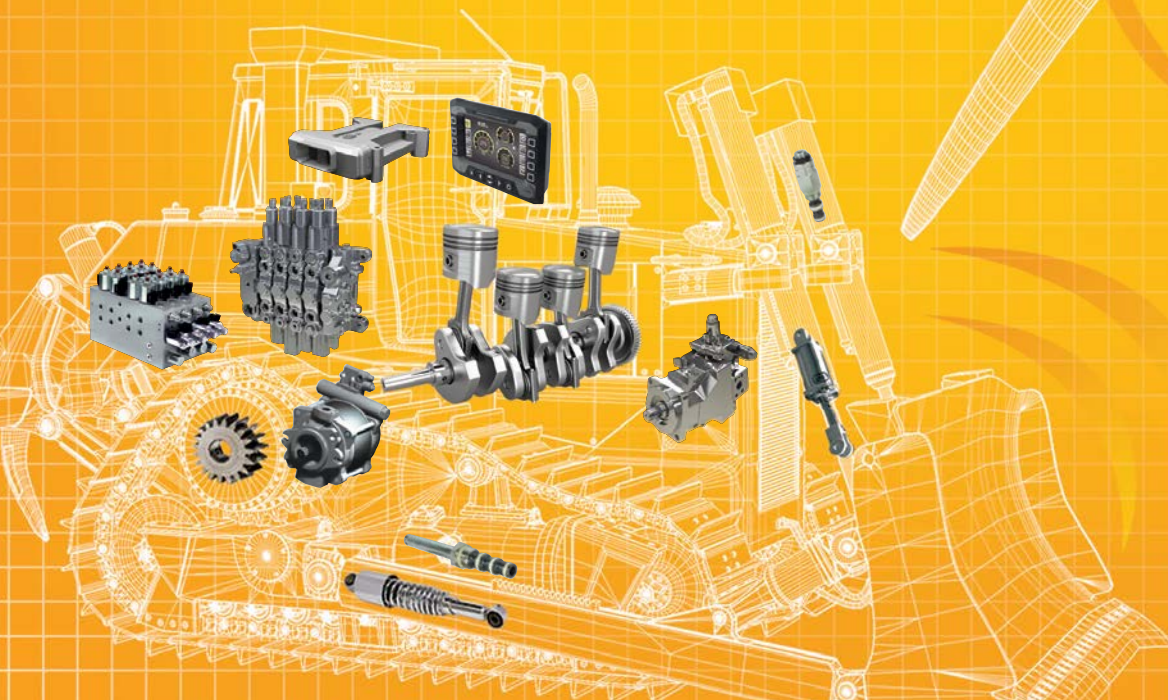
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Phone: (800) 243-2715
info.haydonkerk@ametek.com
www.haydonkerk.com

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6875 US HWY 131
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Fax: (231) 879-4330
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hayescouplings.com

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Fax: (508) 485-7480
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Fax: (916) 373-0952
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NORTHBRIDGE, CA 91324
Phone: (818) 349-5690
Fax: (818) 717-8584
info@heliumleaktesting.com
heliumleaktesting.com

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HUACHENG INTERNATIONAL CENTER
#9 BUILDING, DAXUE ROAD,
ZHENGZHOU CHINA 450000
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Phone: +(86) 371-86075582
Fax: +(86) 371-60688757
contrust.ruby@gmail.com
www.contrust-gear.com

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Phone: +(41) 71 223 2687
Fax: +(41) 71 223 2687
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www.hoffmann-tech.ch

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HOUSTON, TX 77083
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www.houstonpumpandgear.com

Howdon Power Transmission Limited
PAGANHILL LANE
CAINSCROSS
STROUD GLOS GL5 4JT
UNITED KINGDOM
Phone: +(44) 1453 750814
Fax: +(44) 1453 765320
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PAN CHIAO TAIPEI 100
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Phone: +(886) 2-89645666
Fax: +(886) 2-89641537
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HERTFORD HERTFORDSHIRE SG13 7BL
UNITED KINGDOM
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Fax: +(44) 1992509890
david.proud@altramotion.com
www.huco.com

IADA Ltd
ALGORES WAY
WISBECH
CAMBRIDGE CAMBRIDGESHIRE PE13 2TQ
UNITED KINGDOM
Phone: +(44) 116 239 5099
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www.iadaltd.co.uk

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TORRANCE, CA 90505
Phone: (310) 891-6015
Fax: (310) 891-0815
info@intelligentactuator.com
www.intelligentactuator.com

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MERRIAM, KS 66203
Phone: (913) 261-2148
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www.ibtinc.com

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Phone: (800) 521-2747
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SUITE 300
NORTH CHARLESTON, SC 29405
Phone: (843) 695-6200
americas@goimo.com
www.imo.us

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515 FREDERICK STREET
WAUKESHA, WI 53186-5607
Phone: (262) 547-3357
Fax: (262) 547-2949
info@indclutch.com
www.indclutch.com

Industrial Clutch Parts Ltd.
UNIT 11 BINGSWOOD IND EST
WHALEY BRIDGE HIGH PEAK SK23 7LY
UNITED KINGDOM
Phone: +(44) 1663 734627
Fax: +(44) 1663 733023
chris@icpltd.co.uk
www.icpltd.co.uk

Industrial Friction Materials Ltd.
UNIT 7, EAST MOORS BUSINESS PARK,
EAST MOORS ROAD,
OCEAN PARK
CARDIFF SOUTH GLAMORGAN CF245JX
UNITED KINGDOM
Phone: +(29) 20499111
Fax: +(29) 20490011
info@industrialfriction.com
www.industrialfriction.com

Industrial Indexing Systems
626 FISHERS RUN
VICTOR, NY 14564
Phone: (585) 924-9181
Fax: (585) 924-2169
tinae@iis-servo.com
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N13948 THREE MILE RD.
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Phone: (715) 466-4464
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www.industrialjigandfixture.com/

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P.O. BOX 35 EAST CENTER ST.
WEST MANSFIELD, OH 43358
Phone: (937) 355-4910
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TORRINGTON, CT 06790
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CANADA
Phone: 800-663-2953
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WOOD DALE, IL 60191
Phone: (630) 766-2652
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Phone: (978) 448-6368
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sales@inscocorp.com
www.inscocorp.com

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250 HERBERT AVE
CLOSTER, NJ 07627
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Fax: 201-767-7797
info@intechpower.com
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28 CRICKET DRIVE
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Phone: (215) 728-6804
Fax: (215) 745-9459
admin@intellidrives.com
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TAMPA, FL 33626
Phone: (727) 271-0869
sales@interinar.com
www.interinar.com

Intermot S.r.l.
VIA LUSSEMBURGO, 1
MODENA ITALY 41122
ITALY
Phone: +(39) 0598396661
Fax: +(39) 0598396662
intermot@intermot.com
www.intermot.com

International Distribution Alliance, Inc.
1125 MILFORD AVENUE
ROCKFORD, IL 61109
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Fax: (815) 227-9012
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InvenSense
1197 BORREGAS AVENUE
SUNNYVALE, CA 94089
Phone: (408) 988-7339
Fax: (408) 988-8104
eelam@invensense.com
www.invensense.com

ISC Companies
12905 HIGHWAY 55 WEST
MINNEAPOLIS, MN 55441
Phone: (763) 559-0033
Fax: (763) 559-3148
c.bursack@isccompanies.com
www.isccompanies.com

Italgear S.r.l.
VIA PARINI, 18
CASALECCHIO DI RENO (BOLOGNA) 40033
ITALY
Phone: +(39) 0515-904-90
Fax: +(39) 0516-132-163
info@italgear.com
www.italgear.com

ITAMCO
6100 MICHIGAN ROAD
PLYMOUTH, IN 46563
Phone: (574) 936-2112
Fax: (574) 936-2112
dkneidig@itamco.com
www.itamco.com

ITW Heartland
1601 36TH AVENUE
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Fax: (317) 821-3569
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www.jwwinco.com

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HUNSCHIEDTSTR. 116
44789 BOCHUM, GERMANY
BOCHUM GERMANY 44789
GERMANY
Phone: +(49) 234 339 238
Fax: +(49) 234 339 330
sales@jake-gear.com
www.jake-gear.com

Jason Industrial Inc.
340 KAPLAN DRIVE
FAIRFIELD, NJ 07004
Phone: (973) 227-4904
Fax: (973) 227-1651
inquiries@jasonindustrial.com
www.jasonindustrial.com

JVL Industri Elektronik A/S
BLOKKEN 42
BIRKERØD 3460
DENMARK
Phone: +(46) 45 82 44 40
Fax: +(45) 45 82 55 50
jvl@jvl.dk
www.jvl.dk

K & L Clutch & Transmission
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HURST, TX 76053
Phone: (817) 267-0129
kandlclutch@gmail.com
www.klclutch.com

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SOUTHGATE, MI 48195
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Fax: (734) 759-0082
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www.k-and-s.com

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P.O. BOX 619
BUFFALO, NY 14213
Phone: (716) 549-5534
Fax: (716) 549-6595
info@kamarindustries.com
www.kamarindustries.com

Kapsyn Manufacturing Company
AUJLA ROAD,
PO MANSOORWAL DONA,
KAPURTHALA PUNJAB 144601
INDIA
Phone: +(91) 1822 237209
Fax: +(91) 1822 233452
kapsyn@vsnl.com
www.kapsyn.com

Kateel Engineering Industry (P) Ltd, Gear Division
#446, 12TH CROSS, PEENYA INDUSTRIAL AREA,
4TH PHASE,
BANGALORE KARNATAKA 560058
INDIA
Phone: +(91) 8028360357
Fax: +(91) 8028360357
info@kateel.com
www.kateel.com

Kavlico Corporation
14501 PRINCETON AVENUE
MOORPARK, CA 93021
Phone: (805) 523-2000
Fax: (805) 523-7125
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www.kavlico.com

Kaydon Corporation Bearings Division
2860 MCCracken STREET
MUSKEGON, MI 49441
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Fax: (231) 759-4102
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8803 SORENSEN AVE.
SANTA FE SPRINGS, CA 90670
Phone: (562) 907-7650
Fax: (562) 907-7650
sales@kb-controls.com
www.kb-controls.com

Kbk Antriebstechnik GmbH
UNTERLANDSTRASSE 46
KLINGENBERG BAVARIA 63911
GERMANY
Phone: +(49) 9372-130-486-0
Fax: +(49) 9372-134-730
s.karpstein@kbk-antriebstechnik.de
www.kbk-antriebstechnik.de

Kilian Manufacturing Corp.
P.O. BOX 6974
1728 BURNET AVE.
SYRACUSE, NY 13217
Phone: 315-432-0700
Fax: 315-432-1312
dom.leo@kilianbearings.com
www.kilianbearings.com

Kinefac Corporation
156 GODDARD MEMORIAL DR.
WORCESTER, MA 01603
Phone: (508) 754-6891
Fax: (508) 756-5342
sales@kinefac.com
www.kinefac.com

Kinematics Manufacturing, Inc.
21410 N. 15TH LANE, 104
PHOENIX AZ 85027
Phone: 623 780 8944
info@kinematicsmfg.com
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KISSsoft, USA, LLC
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JOHNSBURG, IL 60050
Phone: (815) 363-8823
Fax: (815) 363-8823
info@kisssoft.com
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P.O. BOX 4886
BALTIMORE MD 21211
Phone: (410) 467-0878
Fax: (410) 467-6891
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www.linkgear.com

Linn Gear
100 N 8TH ST.
P.O. BOX 397
LEBANON, OR 97355
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Fax: (541) 259-1299
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GENEVA, IL 60134
Phone: (630) 262-0601
sales@lycbearings.com
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101 CUMMINGS DRIVE
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Phone: 859-291-0849
info@machiii.com
www.machiii.com

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Phone: +(44) 0 1727 814 400
Fax: +(44) 0 1727 814 401
info@cce-international.com
www.cce-international.com

Magnetic Sensors Corporation
1365 N MCCAN STREET
ANAHEIM, CA 92806
Phone: (714) 630-8380
bhilborn@magsensors.com
www.magsensors.com

Magnetic Technologies Ltd
P.O. BOX 257
43 TOWN FOREST RD
OXFORD, MA 01540
Phone: (508) 987-3303
Fax: (508) 987-2875
sales@magnetictech.com
www.magnetictech.com

Magnum Manufacturing
39140 WEBB DRIVE
WESTLAND, MI 48185
Phone: (734) 727-0560
sales_info@magnum-mfg.com
magnum-mfg.com

Magtech
P.O. BOX 257
43 TOWN FOREST RD
OXFORD, MA 01540-0257
Phone: (508) 987-3303
Fax: (508) 987-2875
hshwerdlin@magnetictech.com
www.magnetictech.com

Magtrol, Inc.
70 GARDENVILLE PARKWAY
BUFFALO, NY 14224
Phone: (716) 668-5555
Fax: (716) 668-8705
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100 E. RANDOLPH STREET
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Phone: (985) 580-1672
Fax: (985) 580-1616 chris@marinespecialties-inc.com
www.marinespecialties-inc.com

Mark Elektriks
15, GULTEKDI INDUSTRIAL ESTATE
PUNE MAHARASHTRA 411037
INDIA
Phone: +(91) 20 66016312
Fax: +(91) 20 66016311
markelektriks@vsnl.net
www.markelektriks.com

Marland Clutch
449 GARDNER ST.
SOUTH BELOIT, IL 61080
Phone: 630-455-1752
Fax: 630-455-1794
info@marland.com
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923 SOUTH MAIN STREET
ALGONQUIN, IL 60102
Phone: (847) 658-8130
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www.wolfautomation.com

Marswell Engineering Ltd.
2/F, BLOCK C, WANG YIP CENTRE,
18 WANG YIP STREET EAST,
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Fax: +(852) 2897 5690
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www.marswell.com

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ARLINGTON, TX 76015
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www.martinsprocket.com

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154 HOBART ST.
HACKENSACK, NJ 07601
Phone: (201) 343-8983
Fax: (201) 343-2132
main@masterbond.com
www.masterbond.com

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201 W. MCBEE AVE
SUITE 303
GREENVILLE, SC 29601
Phone: (864) 312-5102
Fax: (864) 312-5119
info@master-pt.com
www.master-pt.com

Matrix International
EAST MILL RD.
BRECHIN ANGUS DD9 7EP
UNITED KINGDOM
Phone: +(44) 1356602000
sales@matrix-international.com
www.matrix-international.com

Maurey Manufacturing Corporation
410 INDUSTRIAL PARK DRIVE
HOLLY SPRINGS MS 38635
Phone: (800) 284-2161
Fax: (662) 252-6364
chuckl@maurey.com
www.maurey.com

MAV S.p.A.
VIA VENEZIA 12
BOSENTINO TRENTO 38040
ITALY
Phone: +(39) 0461845151
Fax: +(39) 0461845150
info@mav.it
www.mav.it

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C/EMPORDA 11-13
SANTA PERPETUA, DE MOGODA BARCELONA
E-08980
SPAIN
Phone: +(34) 935 743 690
Fax: +(34) 935 743 570
mavilor@mavilor.es
www.mavilor.es

Maxon Precision Motors Inc
101 WALDRON RD
FALL RIVER, MA 02720
Phone: (508) 677-0520
Fax: (508) 677-0530
info@maxonmotorusa.com
www.maxonmotorusa.com

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4 NORTH STREET
WALDWICK, NJ 07463
Phone: (201) 445-7210
Fax: (201) 445-8019
info@mayrcorp.com
www.mayrcorp.com

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www.meansindustries.com

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Fax: (757) 766-4297
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Phone: (920) 336-7382
Fax: (920) 336-2983
sales@mecagb.com
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VIA TRIESTE 16
MATHI TO 10075
ITALY
Phone: +(39) 0119268052
Fax: +(39) 0115505095
chiara.tadolini@megadyne.it
www.megadyne.it

Metallized Carbon Corporation
19 SOUTH WATER STREET
OSSINGEN, NY 10562
Phone: (914) 941-3738
Fax: (914) 941-4050
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www.mgt.com.au

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micomail@mico.com
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BUCCINASCO MILANO 20090
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Fax: +(39) 0248-403-899
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www.microingranaggi.it

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CLEARWATER, FL 33762
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KAPURTHALA PUNJAB 144601
INDIA
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Fax: +(91) 1822-232909
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GREENWOOD, IN 46143
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UNITED KINGDOM
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INDIA
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Fax: +(91) 181 2650625
info@neelkanthbeltings.com
www.neelkanthbeltings.com

Netshape Technologies, Inc.
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Phone: (812) 248-9273
solutions@netshapetech.com
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14/7, MATHURA ROAD
FARIDABAD
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gj@nawgears.com
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27 MILL STREET
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VADNAIS HEIGHTS, MN 55127
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CHINA
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Fax: +(86) 574-63785557
llm@cn-slw.com
www.cn-slw.com

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CHARLOTTE, NC 28273
Phone: (704) 583-0008
Fax: (704) 504-0608
gearsales@nissei-usa.com
www.nissei-usa.com

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ENNSER STRASSE 41A
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AUSTRIA
Phone: +(43) 7252 86667
Fax: +(43) 7252 86667-59
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JOHN STREET WEST
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UNITED KINGDOM
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Fax: +(44) 1241-873-636
amassie@ntgear.co.uk
www.ntgear.co.uk

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UNIT 6 STATION ROAD
GAMLINGAY
SANDY BEDFORD SG19 3HB
UNITED KINGDOM
Phone: +(44) 1767 651485
sales@norwin.co.uk
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Phone: +(54) 11-4303-8989
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www.oelheld-us.com

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FOXWOOD ROAD
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www.ongears.co.uk

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CANADA
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CHINA
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Fax: +(86) 755-26826245
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Fax: (847) 578-1200
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Fax: (630) 739-6665
khansen@performance-gear.com
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P.O. BOX 21
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sales@perrygear.com
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LONAVLA MAHARASHTRA 410401
INDIA
Phone: +(91) 2114-272570
Fax: +(91) 2114-270563
pethe_engineering@vsnl.net
www.pethe.in

Philadelphia Gear Corp.
901 EAST 8TH AVENUE
SUITE 100
KING OF PRUSSIA, PA 19406
Phone: (800) 766-5120
Fax: (610) 337-5637
apomeran@philagear.com
www.philagear.com

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600 BLAIR PARK RD., SUITE 220
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Fax: (508) 832-0506
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86 BENSON RD
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Fax: (203) 758-8271
info@pic-design.com
www.pic-design.com

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113-B ANGAPPA NAICKEN ST
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CHENNAI TAMIL NADU 600 001
INDIA
Phone: +(91) 44-2533-1018
Fax: +(91) 44-3935-1992
pioneerbearing@gmail.com
www.pioneerbearing.in

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Phone: (800) 621-1945
Fax: (323) 722-1699
pbctool@aol.com
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GOREGOAN EAST
MUMBAI MAHARASHTRA 400063
INDIA
Phone: +(91) 22 26854126
Fax: +(91) 22 26854863
sales@popularmechworks.com
www.popularmechworks.com

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WEST CHESTER PENNSYLVANIA 19382
Phone: 610-235-5499
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www.ptegears.com

Power-Motion Technology Representatives Associatio

16A JOURNEY, SUITE 200
ALISO VIEJO, CA 92656
Phone: (949) 859-2885
Fax: (949) 855-2973
jay@ptrra.org
www.ptrra.org

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WINCHESTER HOUSE
36 WINCHESTER ROAD
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Fax: +(44) 1932 325353
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CANADA
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www.precisionspindleinc.com

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MECKESHEIM D 74909
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Fax: +(49) 62 26 78 70 29
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www.printedmotors.com

Process Gear

3860 NORTH RIVER ROAD
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Fax: (804) 780-2230
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Fax: (810) 229-8125
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BUCZEK 98-113
POLAND
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office@plants.pl
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2980 FIRST ST. BLDG. "F"
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INDIA
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Fax: (214) 358-5588
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ANSONIA, CT 06401
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www.renebaerag.ch

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Phone: +(44) 11 59 51 88 00
Fax: +(44) 11 59 51 88 01
sales@romaxtech.com
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PO BOX 219
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Phone: +(215) 455-4900
Fax: +(215) 455-8888
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CESKYCH BRATRI 338
NACHOD 547 36
CZECH REPUBLIC
Phone: +(420) 491-447-559
Fax: +(420) 491-447-569
sklad@rubena.cgs.cz
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Rubicon Gear Inc.
1550 E. MCFADDEN AVE.
SANTA ANA, CA 92705
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Fax: 800-635-6273
sales@rushgears.com
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S.M. Shah & Company
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CROSSROADS,
63 TARDEO ROAD
MUMBAI MAHARASHTRA 400034
INDIA
Phone: +(91) 22-23530391
Fax: +(91) 22-23520108
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INDIA
Phone: +(91) 11 25937096
Fax: +(91) 11025167096
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Sam Gears India Pvt.ltd
18/37, SITE IV SAHIBABAD
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TURKEY
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DENMARK
Phone: +(45) 48 17 27 02
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mbl@scancon.dk
www.scancon.dk

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FORT MILL, SC 29715
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info.de@schaeffler.com
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scott.harmon@schneeberger.com
www.schneeberger.com

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www.sensorprod.com

Sensor Technology Ltd.

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IRONSTONE LANE,
WROXTON,
BANBURY OXFORDSHIRE OX15 6AY
UNITED KINGDOM
Phone: +(44) 0-1869-238400
Fax: +(44) 0-1869-238401
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www.sgf.de

Shanthy Gears

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Fax: +(91) 4222-273-884/273-885
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ITASCA, IL 60143
Phone: (630) 924-7138
Fax: (630) 924-7382
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Shivam Autotech Ltd.

303, 3RD FLOOR,
SQUARE ONE,
SAKET
NEW DELHI 110017
INDIA
Phone: +(91) 01149242100
adm@shivamautotech.com
www.shivamautotech.com

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ALPHARETTA, GA 30005
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us@siemens.com
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HO LIK CENTRE, 66A SHA TSUI ROAD, TSUEN
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HONG KONG
CHINA
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sales@silvertech.com.hk
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WEBSTER (HOUSTON), TX 77598
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BOLOGNA ITALY 40050
ITALY
Phone: +(39) 0516714811
Fax: +(39) 0516714858
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Fax: +(44) 115 958 1583
info@smartmt.com
www.smartmt.com

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POST OFFICE BOX P182
S. DARTMOUTH, MA 02748
Phone: (508) 979-5935
Fax: (508) 979-5845
info@smma.org
www.smma.org

Society of Tribologists and Lubrication Engineers

840 BUSSE HIGHWAY
PARK RIDGE, IL 60068
Phone: (847) 825-5536
Information@stle.org
www.stle.org

Sokhi Heli-Wom Gears Pvt. Ltd.

61/22 SITE-4 SAHABABAD INDUSTRIAL AREA
GHAZIABAD U.P. 201010
INDIA
Phone: +(91) 01204344400
Fax: +(91) 01204168468
sokhi@gearboxindia.com
www.gearboxindia.com

Somaschini North America LLC

4601 NIMTZ PARKWAY
SOUTH BEND, IN 46628
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Fax: 574-239-2158
pmorrison@southbendgear.com
www.southbendgear.com

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LUDHIANA PUNJAB 141003
INDIA
Phone: +(91) 1612-531218/532135
Fax: +(91) 1612-532715/534313
info@sondgears.com
www.sondgears.com

Source Engineering Inc.

3283-H, DE LA CRUZ BLVD
SANTA CLARA, CA 95054
Phone: (408) 980-9822
Fax: (408) 980-1860
rick@sei-automation.com
www.sei-automation.com

Southern Gear & Machine Inc.

3685 NW 106TH STREET
MIAMI, FL 33147-1030
Phone: (305) 691-6300
allanarch@southerngear.net
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CORONA, CA 92880
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www.spgear.com

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PRESOV 08001
SLOVAKIA
Phone: +(421) 905570006
info@spinea.sk
www.spinea.sk

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UNITED KINGDOM
Phone: +(44) 1827 872771
sales@splinegauges.co.uk
www.splinegauges.co.uk

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GERMANY
Phone: +(49) 9081-214-0
Fax: +(49) 9081-214-111
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www.spn-hopf.de/index.
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UNIT C2
RUDFORD INDUSTRIAL ESTATE
FORD
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UNITED KINGDOM
Phone: +(44) 1243 558080
Fax: +(44) 1243 558099
info@sprint-electric.com
www.sprint-electric.com

Sprockets Australia Pty. Ltd.

PO BOX 114
YARRAVILLE
MELBOURNE VIC 3013
AUSTRALIA
Phone: +(61) 3-9687 8177
Fax: +(61) 3-9687 8035
sales@sprocketsoz.com.au
sprocketsoz.com.au

SSJ Italy

VIA PASTEUR 16/10
REGIO EMILIA RE 42100
ITALY
Phone: +(39) 0522 552 237
Fax: +(39) 0522 552 237
sales@ssjitaly.com
www.ssjitaly.com

SSS Clutch Co.

610 WEST BASIN ROAD
NEW CASTLE, DE 19720
Phone: (302) 322-8080
Fax: (302) 322-8548
engineering@sssclutch.com
www.sssclutch.com

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5304 HOPE LANE
HOUSE SPRINGS, MO 63051
Phone: (636) 677-5552
Fax: (636) 677-3652
tim@stgearandmachine.com
www.stgearandmachine.com

Stafford Manufacturing Corp.
PO BOX 277
NORTH READING, MA 01864
Phone: (800) 695-5551
Fax: (800) 649-5101
sales@staffordmfg.com
www.staffordmfg.com

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KANDIVALI - WEST
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INDIA
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www.stargears.in

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Fax: (414) 277-4364
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www.rexnord.com

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183 AJIT NAGAR
PATIALA PUNJAB 147001
INDIA
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Fax: +(91) 175-2212963
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SUITE 200
BURLINGTON, MA 01803
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Fax: (781) 273-6602
jskaltas@steinmeyer.com
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Phone: 716-250-1900
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www.stellartech.com

Stephenson Gobin Transmissions
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OHY
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Phone: +(44) 1388832252
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HEIDELBERG 69126
GERMANY
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www.suco-tech.com

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ROME, GA 30162
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transmission@suhner.com
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CHINA
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www.szapmc.com

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SOUTH SHANXI RD.
SHANGHAI 200001
CHINA
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T.E.A. Machine Components
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RICHMOND, VA 23139
Phone: (804) 342-0004
Fax: (804) 342-0006
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Taiwan Precision Gear Corp.
NO. 136-2, ALLEY 5, LANE 123, SHOU PI
FENG YUENG CITY TAICHUNG 420
TAIWAN
Phone: 886-4-25351329
Fax: 886-425351467
tpgcorp@ms13.hinet.net
www.tpg-tw.com

Taiwan United Gear Co., Ltd.
RM. 1212, NO.205, SEC. 1, FUXING S. RD.
DA'AN DIST., TAIPEI CITY 106
TAIWAN
Phone: +(886) 3-352-0605
Fax: +(886) 3-321-7598
sales@tugc.com.tw
tugear.com.tw/about-us.php

Taizhou Heri Autoparts Co. Ltd.
ROOM 1707, NO 127 CHANGSHOU ROAD
SHANGHAI 200060
CHINA
Phone: +(86) 21 62773282
Fax: +(86) 21 62773283
office@heri-sh.com
www.heri.net.cn

Tapeswitch Corporation
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FARMINGDALE, NY 11735
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CHAMBERSBURG, PA 17201
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Fax: 7172646420
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DETROIT LAKES, MN 56501
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Fax: (218) 847-1052
info@team-ind.com
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www.technico.com

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Fax: 0031 546 536310
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ROUND ROCK, TX 78681
Phone: (404) 229-8738
Fax: (512) 248-5617
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www.tecowestinghouse.com

Tecslia Lubricants Pte Ltd
10534 SUCCESS LANE, SUITE D
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Phone: (937) 866-6889
sales@tecsialube.com
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Phone: (610) 692-2576
sales@tefcap.com
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Terog Manufacturing / Black Ace Parts
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Phone: (800) 423-3918
Fax: (218) 478-3622
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www.tpa-us.com

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www.thk.com

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PIOVE DI SACCO PADOVA 35028
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Phone: +(39) 0499-700-188
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www.toffac.com

Toledo Gearmotor A Bluffton Motor Works Company
5439 ROAN ROAD
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Phone: (800) 488-7072
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customerservice@toledogear.com
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Tolomatic, Inc.
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HAMEL, MN 55340
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Fax: 763-478-8080
sales@tolomatic.com
www.tolomatic.com

Tool Masters India
C-36 FOCAL POINT
PATIALA PUNJAB 147003
INDIA
Phone: +(91) 175-2232808
Fax: +(91) 175-5001405
toolmasters@gmail.com
www.tool-masters.com

Top Machinery & Equipment (Zhengzhou) Ltd
10-1509#, 73 WEILAI ROAD,
ZHENGZHOU HENAN 450008
CHINA
Phone: +(86) 371 65523361
Fax: +(86) 371 65614031
export@top-rol.com
www.top-rol.com

Torque Transmission

1246 HIGH STREET
FAIRPORT HARBOR, OH 44077
Phone: (440) 352-8995
Fax: (440) 352-7682
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www.torquetrans.com

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BOLOGNA 40012
ITALY
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Fax: +(39) 0517-289-37
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www.tramec.it

Transfluid

150 AUBURN PARK DRIVE
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Fax: (770) 822-1777
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HSIN LI
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TAIWAN
Phone: +(886) 6 5831177
transtec@seed.net.tw
www.transyko-transtec.com

Transmotec AB

POLYGONVÄGEN 49
187 66 STOCKHOLM
SWEDEN
Phone: +(46) 8 792 35 30
Fax: +(46) 8 792 35 20
inquiry@transmotec.com
www.transmotec.com

Transply Inc.

P.O. BOX 7727
YORK, PA 17404
Phone: (717) 767-1005
Fax: (717) 767-9410
sales@transply.com
www.transply.com

Triumph Group

899 CASSATT ROAD
SUITE 210
BERWYN, PA 19312
Phone: (610) 251-1000
Fax: (610) 251-1555
solutions@triumphgroup.com
www.triumphgroup.com

Trojon Gear Inc.

418 SAN JOSE STREET
DAYTON, OH 45403
Phone: (937) 254-1737
Fax: (937) 254-3029
timwhite@trojon-gear.com
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P.O. BOX 12012
ROTTERDAM 3004 GA
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Fax: +(31) 10 4626240
info@tssr.nl
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1630 DREW ROAD
MISSISSAUGA ON L5S 1J6
CANADA
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Fax: (905) 676-0904
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www.tsubaki.ca

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Fax: +(81) 774-64-5212
pt.com@tsubakimoto.com
tsubakimoto.com

Turbo Power

116 CANAL DRIVE
FRIENDSWOOD, TX 77546
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Fax: (309) 213-0126
turbopower@houston.rr.com
www.turbopower.info

TVT America, Inc.

210 EAST MAIN STREET
HOLDENVILLE, OK 74848
Phone: (866) 285-5055
Fax: (866) 768-4927
sales@tvtafrica.com
www.tvtafrica.com

Twiflex Limited

104 THE GREEN
TWICKENHAM MIDDLESEX TW12 5AQ - UK
UNITED KINGDOM
Phone: 442088941161
Fax: 442088946056
sales@twiflex.com
www.twiflex.com

U.S. Gear

9420 STONY ISLAND AVE.
CHICAGO, IL 60617
Phone: (773) 375-4900
Fax: (773) 375-4557
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www.usgear.com

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www.ustsubaki.com

Ultra Motion

22355 ROUTE 48, #21
CUTCHOGUE, NY 11935
Phone: (631) 298 9179
Fax: (631) 298 6593
info@ultramotion.com
ultramotion.com

Unigear Industries

20375 CLARK GRAHAM
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CANADA
Phone: (514) 457-7700
roberth@unigear.com
www.unigear.com

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AVENEL, NJ 07001
Phone: (732) 882-0777
Fax: (732) 882-1777
reception@uniquetechnologies.com
www.uniquetechnologies.com

United Gear and Assembly, Inc

1700 LIVINGSTONE ROAD
HUDSON, WI 54016
Phone: (715) 386-5867
Fax: (715) 386-6473
www.ugaco.com

Universal Technical Systems, Inc. (UTS)

4053 NORTH PERRYVILLE ROAD
LOVES PARK, IL 61111
Phone: (815) 963-2220
support@uts.com
www.uts.com

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CHINA
Phone: +86-133-42969370
richard@ecodrivecn.com
www.ecodrivecn.com

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THAPURA,
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INDIA
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Valley Gear & Machine Inc.

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Fax: +(32) 11 67 05 62
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27 MULVANEY STREET
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Phone: (828) 285-0495
info@ventureproducts.com
www.ventureproducts.com

Vibracoustics Ltd

UNIT 1 BROOK HOUSE
CROSS STREET
SYSTON
LEICESTER LEICESTERSHIRE LE7 2JG
UNITED KINGDOM
Phone: +44 (0) 116 2605700
Fax: +44 (0) 116 2605707
mail@vibracoustics.com
www.vibracoustics.com

Vision International

127-227, KARMA ESTATE, NR. TRIKAMPURA
PATIA,
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INDIA
Phone: +(91) 9374160151
Fax: +(91) 7940084543
netexim@gmail.com
www.engimech.com

Vision Quality Components, Inc

1433 INDUSTRIAL PARK ROAD
CLEARFIELD, PA 16830
Phone: 614-833-4489
Fax: 614-837-9549
ernie@visionqci.com
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Fax: 1-888-217-7926
Info@vlmotion.com
www.vlmotion.com

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74564 CRAILSHEIM GERMANY
GERMANY
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Fax: +(49) 7951 32-480
startup.components@voith.com
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Fax: (973) 276-7908
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Vortex Engineering Works

PLOT B-3, PHASE-II, M.I.D.C.
DOMBIVLI - 421 204
THANE MAHARASHTRA 421204
INDIA
Phone: +(91) 251-2871339
Fax: +(91) 251-2870044
sales@vortex-clutch.com
www.vortex-clutch.com

VW Broaching Service Inc.

3250 W. LAKE ST.
CHICAGO, IL 60624
Phone: (773) 533-9000
Fax: (773) 533-0763
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www.vwbroaching.com

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DIV. OF REXNORD
5138 S. INTERNATIONAL DR.
CUDAHY, WI 53110
Phone: (414) 747-5800
Fax: (414) 747-5801
WMBergTechSupport@Mailbox@
rexnord.com
www.wmberg.com

Warner Electric

449 GARDNER ST.
S. BELOIT, IL 61080
Phone: (815) 389-3771
Fax: 815-389-2582
info@warnerelectric.com
www.warnerelectric.com

Warner Linear

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BELVIDERE, IL 61008
Phone: 800-825-6544
Fax: 815-547-7206
info@warnerlinear.com
www.warnerlinear.com

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SUITE 200
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Fax: (262) 506-3001
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www.waukbearing.com

WD Bearing America

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www.weg.net

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TIVOLI PARK, BUNGALOW NO. 5,
225 B A.J.C. BOSE ROAD
KOLKATA WEST BENGAL 700020
INDIA
Phone: +(91) 33-22837389 /
32918313
Fax: +(91) 33-22836080
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www.wellmanwacoma.com

Whittet-Higgins Company

33 HIGGINSON AVE
PO BOX 8
CENTRAL FALLS RHODE ISLAND 02863
Phone: (401) 728-0700
Fax: (401) 728-0703
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www.whittet-higgins.com

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How To Use a Hand-Held Micrometer to Measure Miniature and Instrument Ball Bearings

Pacamor Kubar Bearings

For the most accurate measurements, miniature and instrument ball bearing dimensions should be measured with a calibrated air gauge. A good second option is a calibrated optical comparator. On occasion, it may be necessary to use a calibrated, hand-held micrometer to double-check a measurement or for simple verification while working in the field.

While PKB strongly recommends the use of an air gauge or an optical comparator, we also understand the usefulness of a hand-held micrometer in certain situations.

Using a micrometer on delicate objects—like miniature and instrument ball bearings—is very different from using a micrometer on solid objects.

The reason for this is miniature and instrument ball bearing rings are usually quite thin and flexible. Improper micrometer use may cause ring deformation and inaccurate micrometer readings.

To measure a miniature or instrument ball bearing ring without damaging or deforming the ring, it is advisable to use the micrometer as a GO/NO-GO gauge.

How to check minimum tolerance of the dimension by using micrometer as go/no-go gage:

1. Twist the ratchet just until the micrometer gauge reads the minimum tolerance for the dimension to be measured.
 - a. Do not adjust the micrometer while the bearing is in between the anvil and spindle.

- b. Do not squeeze the bearing in between the anvil and spindle head, as that may distort the ring.
2. Lock the micrometer.
3. Using proper bearing handling practices, place the bearing between the anvil and spindle of the micrometer.
4. Do not force the bearing into the micrometer.
5. If the bearing does not fit easily into the micrometer, then the bearing exceeds the minimum tolerance for the dimension.
6. If the bearing fits easily into the micrometer, at the preselected minimum tolerance setting, then the bearing is under / less than the minimum tolerance for the dimension.
7. Remove the bearing from the micrometer and set it aside using proper handling techniques.

How to check maximum tolerance of dimension by using micrometer as go/no-go gage:

1. Twist the ratchet just until the micrometer gauge reads the maximum tolerance for the dimension to be measured.
 - a. Do not adjust the micrometer while the bearing is in between the anvil and spindle.

- b. Do not squeeze the bearing in between the anvil and spindle head as that may distort the ring.
2. Lock the micrometer.
3. Using proper bearing handling practices, place the bearing between the anvil and spindle of the micrometer.
4. Do not force the bearing into the micrometer.
5. If the bearing does not fit easily into the micrometer, then the bearing is larger than the maximum tolerance for the dimension.
6. If the bearing fits easily into the micrometer, at the preselected maximum tolerance setting, then the ring is within the maximum tolerance for the dimension.
7. Remove the bearing from the micrometer and set it aside using proper handling techniques.

Find this and other valuable bearing tutorials on our website (www.pacamor.com) Home Page under “New PKB Blogs.” **PTE**

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Crowning Spur Teeth

THE QUESTION

When designing spur teeth, is there a formula/guideline/design guide for determining the amount of crowning?

Response provided by Octave LaBath.

In September 2005, I produced a spreadsheet comparing four references for crowning on parallel shaft gearing. I have since added a fifth reference:

References on Crowning:

1. McVittie, Don. "Our Experts Discuss Hobbing Ridges, Crooked Gear Teeth and Crown Shaving," *Gear Technology*, March/April 1992, pp. 41-43.
2. Stokes, Alec. *High Performance Gear Design*, Machinery Publishing, 1970, p. 89.
3. Merrit, Henry Edward. *Gear Engineering*, John Wiley & Sons, 1972, p. 124.
4. Dudley, Darle, Ed. *Gear Handbook*, McGraw Hill, 1962, p. 5-24.
5. National Broach & Machine Division. *Modern Methods of Gear Manufacture*, Lear Siegler, Inc., p. 77.

Example 1 (McVittie)

"The amount of crown is critical," McVittie says, "since too much total crown in the pair of gears will concentrate the contact into a narrow area of the face and lead to premature pitting failures. A reasonable rule of thumb is 'no more than .0003 to .0005 inch' of crown per inch of face."

Face 2.000" (50.8mm)
 Crown Minimum = Face • 0.0003 = 0.0006" (0.015 mm)
 Maximum = Face • 0.0005 = 0.001" (0.025 mm)

Therefore the tooth thickness of a 2.0" face width gear would be 0.0012" to 0.0020" less than in the center of the face width.

Example 2 (Stokes)

"For any power gearing application," Stokes says, "it is essential that perfect tooth contact is obtained. To allow for any misalignment in the mountings of the gears, or heat treatment distortion, it is usual to crown the tooth form, i.e., produce elliptoid teeth, thus eliminating any chance of end loading the gear tooth."

According to Stokes, crowning is usually .0002 to .0003 inches crowning per inch of face width, with a maximum of .0005 inches per inch of face width.

Face 2.000" (50.8mm)
 Crown Minimum = Face • 0.0002 = 0.0004" (0.010 mm)
 Maximum = Face • 0.0005 = 0.0006" (0.015 mm)

Example 3 (Merritt)

"Symmetrical crowning is applied in order to avoid hard bearing at tooth-ends, which might otherwise occur as a result of errors of tooth alignment," says Merritt. According to Merritt, crowning can be based on the gear's pitch, with crowning per flank commonly around .005/P to .01/P.

Assuming a square pinion, the pitch diameter would be 2.000 inches.

Pitch 10 NDP (2.54 module), 20 teeth
 Crown Minimum = 0.005/NDP = 0.0005" (0.0127 mm)
 Maximum = 0.01/NDP = 0.0010" (0.0254 mm)

Pitch 20 NDP (1.27 module), 40 teeth
 Crown Minimum = 0.005/NDP = 0.0003" (0.0064mm)
 Maximum = 0.01/NDP = 0.0005" (0.0127 mm)

Example 4 (Dudley)

"In effect, crowning allows a rocking-chair-like action between the teeth when the shafts deflect into increasingly nonparallel positions," Dudley says. "Heavy concentrations of load at the ends of the teeth are avoided." Dudley suggests that the ends of crowned gears are made .0005 to .0020" thinner at the ends as compared to the middle.

Crown Minimum = 0.00025" (0.0635 mm)
 Maximum = 0.0010" (0.0254 mm)

Example 5 (National Broach)

According to this handbook, "Excessive crowning is as great an evil as no crowning. When the amount of crown is too great, effective face width is sacrificed...If the accumulated mounting errors or shaft deflection appear to call for gear tooth crowning in excess of 0.0005-in. per inch of face width on each tooth side, more rigid mounts, or stronger gear teeth should be considered."

Face 2.000" (50.8 mm)
 Crown Maximum = Face • 0.0005 = 0.0010" (0.0254 mm)

Discussion

I prefer the methods that have the amount of crown as a function of the face width. This eliminates References 3 and 4.

The method given in Reference 2 seems to give too small an amount of crown.

The Reference 1 method is similar to the method given in Reference 5, but has a tolerance range. There should be a tolerance on the amount of crown, so I like the method given in Reference 1 best. This reference actually mentions Reference 5.

Octave LaBath enjoyed a 30-plus year career at Cincinnati Gear. A Gear Technology technical editor and longtime AGMA member and contributor of his time and expertise to the association, he now heads up a consultancy—Gear Consulting Services of Cincinnati, LLC—and can be contacted at octave@fuse.net.



Power Transmission Engineering
 "Expert"/Technical Editor Octave
 LaBath with his gear apprentice Max,
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The Workhorse of Industry: The Induction Motor

Dan Jones

History

As with many new inventions, the first practical single-phase induction motors appear to have been invented in 1885 by Galileo Ferraris, an Italian. Two years later, Nicola Tesla, a Serbian-born naturalized citizen of the United States, created the 2-phase induction motor; Tesla was granted U.S. patents in 1887. George Westinghouse employed Tesla for one year to develop the induction motor for his company. The first wound-field, 2-phase AC induction motor product family was announced by Westinghouse in 1892. In 1888, Mikhail Dvovilo Dobrovolsky created a 3-phase induction with a squirrel cage motor. GE began developing 3-phase AC induction motors beginning in 1891 under Charles Steinmetz's leadership. Induction motors continued to evolve in form and use. The 3-phase induction motor is used in the larger horsepower application above 1 hp while the sin-

gle-phase AC motors were used in the smaller, below 1 hp applications.

Construction

The AC induction motor consists of two major assemblies—rotor and stator. AC power in the form of 60Hz sinusoidal signals are fed into the 3-phase stator windings. This rotating magnetic field induces a rotor field in the rotor's shorted (closed circuit) squirrel cage windings. The established rotor field runs at a frequency and rotor shaft speed that is not in synchronism with the rotating stator frequency. This condition, defined as slip, results in the rotor shaft speed to be tens of rpm below the induction motor's synchronous speed (frequency) developed by the stator. The slip value varies between one percent and five percent on most AC induction motors. The 3-phase stator signals establish a series of rotating magnetic vector fields that allow the induction motor to continue to rotate freely without external support.

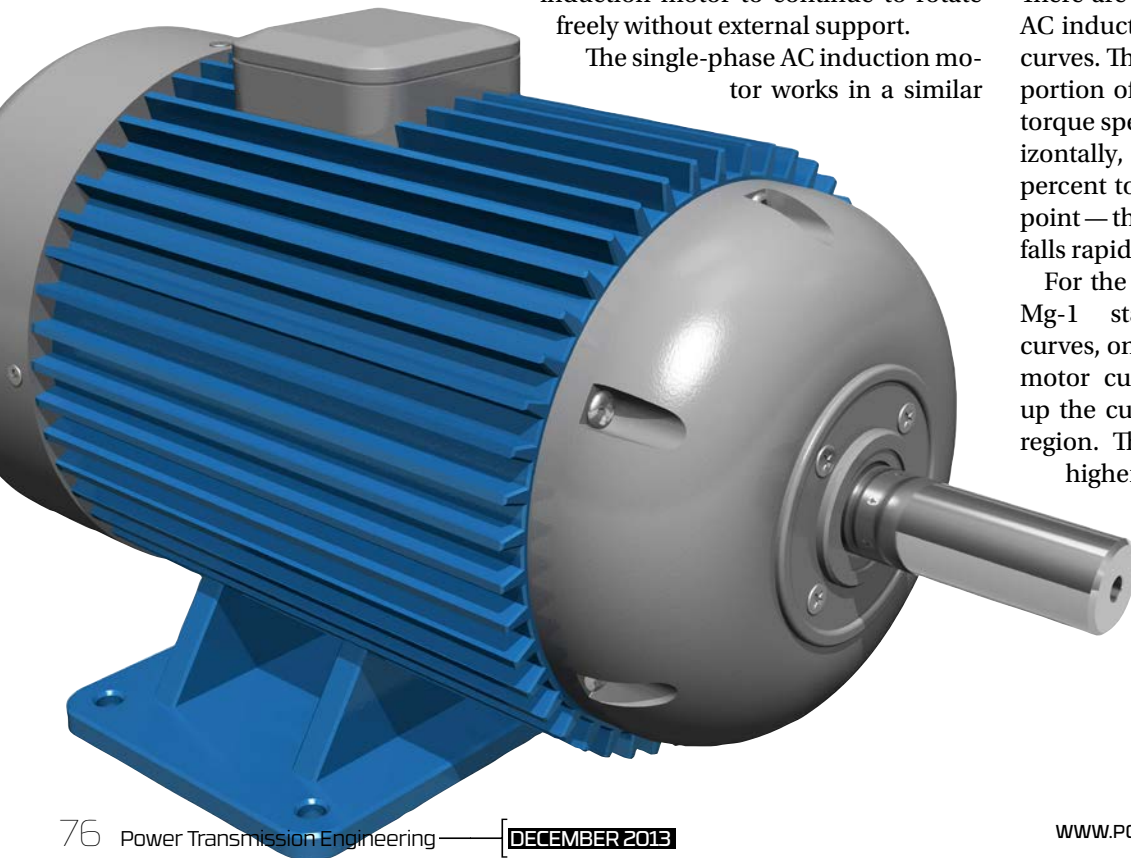
The single-phase AC induction motor works in a similar

manner except it possesses a second winding—or auxiliary winding—that allows one to use a capacitor to establish a near 90 electric degrees between the stator winding and auxiliary winding. This action supports continuous rotor and shaft rotation. The housing, end caps and bearings complete the AC motor construction that supports the motor's rotation (Fig. 1).

Performance

The mechanical output is represented by the motor's torque vs. speed curves, based first on 60Hz input voltage and current inputs, and later on a range of input frequencies. The motor's shaft speed is a function of the number of magnetic poles within the motor. It runs at a no-load speed of almost 3,600 rpm for a 2-pole and 1,800 rpm for a 4-pole. Remember the impact of slip. The AC induction motor's torque vs. speed curve is highly non-linear. There are three different regions on an AC induction motor's torque vs. speed curves. They are the near-vertical-rated portion of the curve (Fig. 2). Once the torque speed curve begins to bend horizontally, one reaches the maximum percent torque point—the breakdown point—the AC induction motors speed falls rapidly to stall or zero speed.

For the design A, B, C and D NEMA Mg-1 standard-rated torque-speed curves, only the design D AC induction motor curves can re-start and move up the curve back to the rated torque region. The price for the Design D's higher starting torque performance is much lower power efficiency. The other three design curves require extra help to return to the rated torque region.



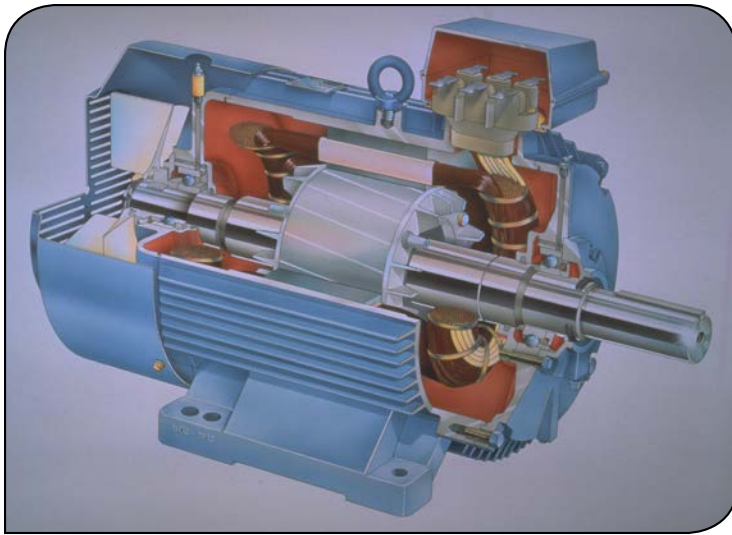


Figure 1

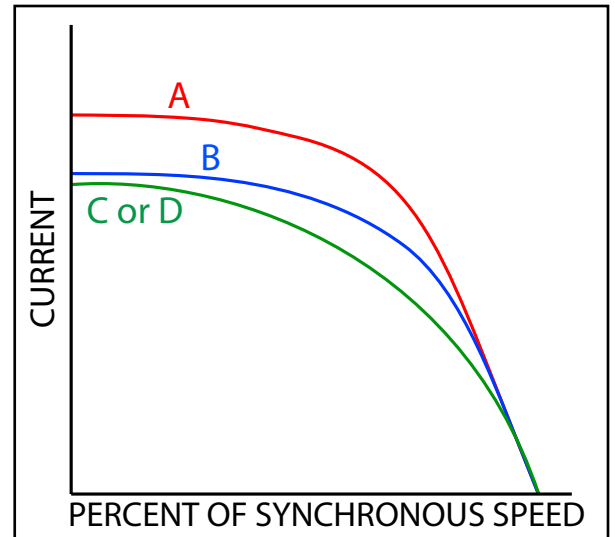


Figure 2

Current is non-linear; the most current for all four design torque-speed curves is drawn at stall (Fig. 3); the Design B curve is the most popular one today. The AC induction motor was originally designed for applications that have a near-constant load. One just plugs the AC induction motor's power cord directly into the 60 Hz wall outlet for constant speed applications. The motor can self-regulate its speed within ± 20 percent of rated load.

Enter the Variable-Speed Drive

The AC induction motor has a flaw when operating in its normal-rated torque region. At very light application loads, it draws nearly the same current at rated load. Power efficiencies could drop to 35 percent from its rated effi-

ciency of 90 percent to 95 percent, depending on an AC motor's hp output.

The emergence of the 3-phase adjustable or variable speed drive (VSD) in the late 1980's provided the AC motor with a much wider speed operation. The variable speed drive is a solid-state power conversion unit that controls the frequency, voltage and current into a 3-phase induction motor. Typical VSDs can seamlessly vary volts and frequency to eliminate the difficulty in high current and low starting torque in AC induction motors. Field weakening, pulse width modulation (PWM), and current control provides other drive strategies available to be more controllable and to maintain high power efficiency over a variable load.

The AC induction motor is the most popular motor for use in a wide range of speed-based applications. Simple in design and rugged in construction, lower in cost and in maintenance—the AC induction motor continues to dominate industrial and powered home applications. **PTE**

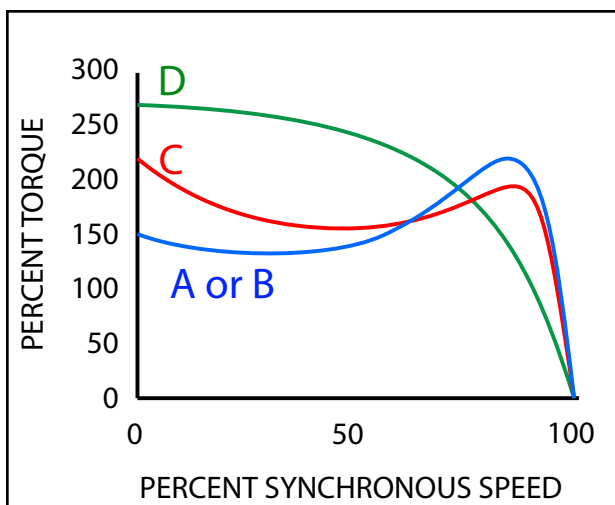



Figure 3

Dan Jones received his BSEE degree from Hofstra University in 1965 and MS in Mathematics at Adelphi in 1969. He has over 50 years' experience in the design of all types of electric motors and generators from 10 W to 500 kW and has held engineering design, management and marketing management positions at a number of companies. He is recognized as an international authority on electric motors and motion control. He has written 250+ technical articles/papers and held seminars in 10 countries. He is a past member of the board of directors of SMMA and EMERF. He currently is a member of the board of directors of the Motion Control Association (MCA). He is a life member of IEEE and a member of ASME. This article was adapted from his seminar on motor types, which is being presented at Motion Control 2013 (October 15–17 in Los Angeles) and at the Motor, Drives and Automation Systems 2014 Show (January 29–30 in Orlando).



Inexpensive Methods to Measure the Performance Characteristics of a Linear Motion Device

Rob Steves

This article describes a series of tests that can be performed by the average user, with little experience, and without sophisticated measuring instruments, to quickly determine the most important performance characteristics of linear motion systems. It is published here courtesy of Zaber Technologies Inc.

Introduction

Any object in space has six degrees of freedom: linear motion along X, Y and Z axes, and rotation about each of those axes. Consider a typical linear motion system—in this case a Zaber T-LSR75D linear slide. With reference to Figure 1, we define a coordinate system as follows:

- X Is the horizontal axis parallel to axis-of-travel
- Y Is the horizontal axis perpendicular to axis-of-travel
- Z Is the vertical axis perpendicular to X and Y axes

Roll Is the rotation about X axis

Pitch Is the rotation about Y axis

Yaw Is the rotation about Z axis

The goal of a single-axis motion control device is to constrain five degrees of freedom while precisely controlling motion in the sixth. In the case of the pictured linear slide, all three rotational degrees of freedom are constrained, as well as two linear degrees of freedom. Motion in the X dimension is controlled.

Anyone who has purchased a linear motion product will recognize these most commonly quoted specifications:

- Range

- Speed
- Load capacity
- Position error (accuracy)
- Repeatability
- Backlash
- Resolution
- Assuming the reader is familiar with these, I will not define them here.

But note that each

of these specs describes behavior in the X dimension only. It may not be obvious, but it should be understood that a similar set of specs exists for each of the six degrees of freedom. It does not matter whether a degree-of-freedom is constrained; what can be measured in one degree of freedom can be measured in another.

In some cases, the values of the corresponding specs are obvious. For example: the “range,” “speed” and “resolution” in any constrained dimension should be 0. In other cases, the spec may be familiar by another name. For example: “horizontal run-out” and “vertical run-out” are familiar specs that simply represent the position error in the Y and Z dimensions, respectively. Other specs are obscure enough that no standard naming convention has been adopted. Consider: while it is not uncommon to see values quoted for the position error in pitch, yaw and roll dimensions, each manufacturer seems to call them something different; still other specs are rarely quoted at all. You are unlikely to

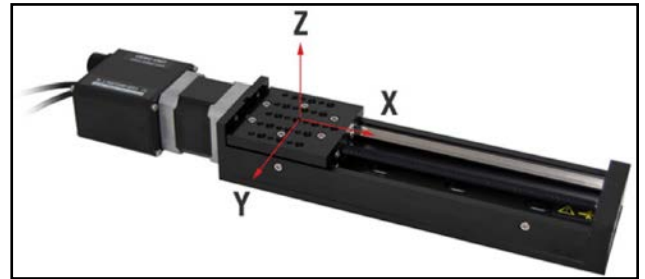


Figure 1 Defining a coordinate system. (all photos courtesy Zaber Technologies).

see repeatability or backlash quoted for anything but the axis-of-travel, though these specs certainly do exist in the other degrees of freedom. While certain specs are rarely quoted, their values are often required by the user. Sometimes the only way to obtain these specs is DIY—do your own device testing. It is that process with which the remainder of this article is concerned.

Test Equipment

The test subject and some typical test equipment are shown (Fig. 2). At the top-left is an optical bread board (an anodized aluminum plate with tapped holes at regular intervals). At top-right is a granite surface plate. Surprising accuracy in a surface plate can be had at very little expense these days; about \$40 will buy you a 12" × 12" surface plate certified flat to within 0.0001". Note at the bottom of the figure two dial indicators with divisions of 0.0005" and some hardware for mounting them in various configurations; you will see other equipment used in the remaining figures, but it is all variation of the same theme.

Measuring speed. Typically the only axis of interest with regard to speed is the X axis (the axis of travel). There is invariably some motion in the other degrees of freedom, which we will



Figure 2 Test subject and test equipment.

measure shortly—but usually only the position error and not the speed is of concern. Along the axis of travel there are several speed-related specs the user may be interested in; these are minimum speed; speed resolution; speed error (accuracy); and maximum speed. Only specific, discrete speeds can be achieved by a digital control system. The minimum speed is typically the same as the speed resolution, and these are usually pre-defined by the control hardware and can be determined simply by referring to the “set speed” instruction or the equivalent that should exist for any motion system.

The speed error can be determined relatively easily with an ordinary stopwatch. Simply set the acceleration to 0, set the speed to a low value, and execute a move instruction calculated to take exactly 1,000 seconds to complete. Using a stopwatch—even accounting for human error—it’s easy to achieve ± 1 second timing accuracy. So for a 1,000-second move you should be able to measure the speed to an accuracy of ± 0.1 percent.

If you require more accuracy you can try executing a move that takes 10,000 seconds to complete, thereby achieving ± 0.01 percent accuracy in measurement of the speed. If you have all day—literally—you can try 100,000 seconds to obtain ± 0.001 percent accuracy. This assumes you have a stopwatch that is accurate to better than one-second-per-day. If the motion device is computer-controlled, as our test subject happens to be, measuring the speed is much easier.

A test script can be written to execute a move, measure how much time it takes to complete, and calculate and display the actual speed and the speed error. Note, however, that operating systems are non-deterministic and may not be able to measure completion time any more accurately than a person with a stopwatch, depending upon which processes are running on the machine. The maximum speed can be determined by trial and error, but note that it will likely be load-dependent.

Measuring load capacity. The load applied to a linear motion device can be in the form of forces along X, Y and Z axes—or moments about those

axes. For example, a centered weight mounted to the stage applies a force only in the Z dimension. If the weight is not centered, it applies both a force in the Z dimension and a moment about the X or Y axis—or both. These forces and moments will affect both the lifetime of the device as well as its ability to even move. There are two load specs commonly quoted: 1) the maximum load—above which the slide will stall; and 2) the recommended load—above which the lifetime of the slide may be reduced below the warranty period. Often, only the recommended load is quoted since manufacturers are not keen on encouraging users to push their devices to an early demise. However, users should be aware that the recommended load can often be exceeded by a significant margin if the corresponding reduction in lifetime is tolerable.

The maximum load is usually dependent on the speed. To measure it, a known force or moment—or a combination of a force and a moment since it is difficult to separate the two—can be applied by attaching fixed weights to the stage. Then the speed can be varied to determine the maximum achievable value. Testing a few different weights and interpolating will yield a reasonable plot of the maximum load as it varies with speed.

Determining the effect of load on lifetime is not nearly as easy as determining the effect of load on speed. It requires the cycle-testing of several devices until failure occurs at different loads—which is usually not practical for the end-user. For the manufacturer, however, it is often the case that individual components, such as bearings and rails, can simply be replaced for successive tests, thus reducing the cost of lifetime testing significantly.

Measuring position error. As mentioned, position error is generally the spec of greatest concern. Position errors can be measured in each of the six degrees of freedom. Often a sin-

gle setup can be used to measure a position error in both a linear and a rotary dimension simultaneously.

Measuring Y error and yaw error. The setup for measuring the yaw error also serves to measure the Y error (Fig. 3). The granite surface plate is mounted parallel to the linear slide; the two dial indicators are mounted to the stage in such a way that their contact probes gently touch the vertical side of the granite surface plate. The surface plate is aligned parallel to the slide in such a way to minimize the change in dial gage readings over the range of travel of the slide.

In order to measure only yaw with no component of roll, it is important that the contact points of the probes with the surface plate lie in the same plane as the slide’s bearings. Observing this setup, one can see that small motions in Z and X directions will have no effect on the dial readings; nor will small changes in pitch or roll angle. Thus it is clear that this is a good setup for measuring Y and yaw position errors.

At several locations throughout the travel of the slide, readings can be taken from both dial gages. At each location, the Y position can be calculated as the average of the two dial readings, while the yaw angle (in radians) is the difference between the two readings divided by the distance between the probes (5” in this case). The maximum variation in Y position and yaw angle over the full range of travel gives the Y error and yaw error, respectively. The Y error is more commonly referred to as the “horizontal run-out.”

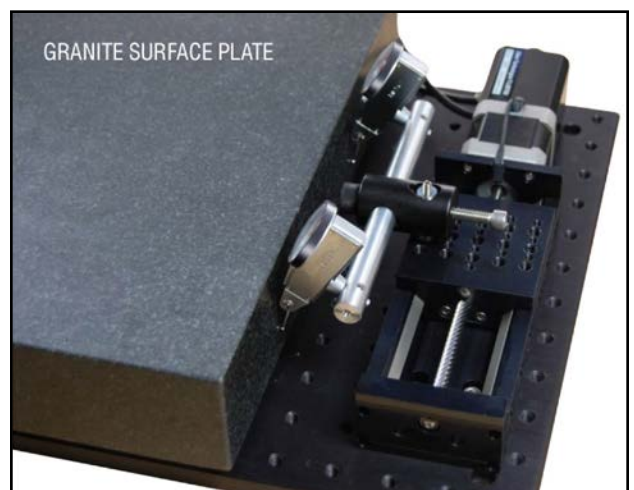


Figure 3 Setup for measuring Y error and yaw error.

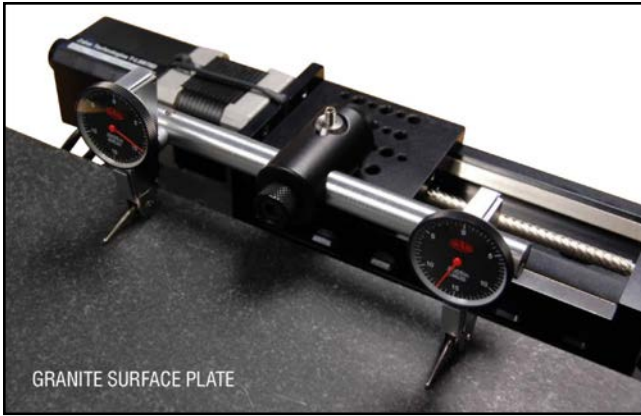


Figure 4 Setup for measuring pitch error.

Measuring pitch error. Pitch error, in this context, should not be confused with lead screw pitch error. Lead screw pitch error manifests itself as a contribution to the X error, which will be measured later. The pitch error, in this context, refers to the variation in pitch angle of the slide platform as it travels over its full range of motion in the X dimension.

The setup for measuring the pitch error is shown (Fig. 4). It is similar to that for measuring the yaw error, but the probes of the dial gages are run against the horizontal edge of the granite surface plate, rather than the vertical edge. Again it is important that the points of contact with the surface plate lie in the same plane as the linear slide bearings. The slide has been raised off the optical breadboard on pillars to achieve this. One can see that small motions in X or Y have no effect on the dial readings; nor small changes in yaw angle. Changes in Z position and roll angle will affect the readings of the gages, but both gages will be affected equally. Since the pitch angle is related to the difference between the two readings, its measurement will not be adversely affected by the Z error or roll error.

The pitch angle (in radians) is given by the difference between the two readings divided by the distance between the probe contact points (5"). The variation in measured pitch angle over the full travel gives the pitch error. One might be tempted to use this setup to measure the Z error as well, but that would be a poor choice since it would be impossible to distinguish the Z error from the component of roll error that would also be measured.

Measuring Z error and roll error.

The setup for measuring the roll error is shown (Fig. 5). The linear slide and granite surface plate are kept in the same positions as for pitch measurement, but the dial gage setup is turned so that the points of contact lie along the Y axis. One can see that small motions in X and Y will have no effect on the dial readings; nor will small changes in pitch or yaw angle. Therefore this is a good setup for measuring Z error and roll error, provided there is a way to distinguish between the two.

The dial gages are set up such that the points of contact are 2.5" apart and the contact point of the right-most probe is 2.5" from the center of the stage. It may not be immediately obvious, but a little geometry will show that the Z position is given by doubling the right-most reading and subtracting the left-most reading.

The roll angle is given by the difference between the two readings divided by the distance between the probes (2.5" in this case). The variation in Z position and roll angle over the full range-of-travel gives the Z error and roll error, respectively. Z error is more commonly referred to as "vertical run-out." There are simpler methods of measuring the Z error if that is your only interest, but if you are measuring position errors in all degrees of freedom, measuring Z error and roll error with the same setup is convenient.

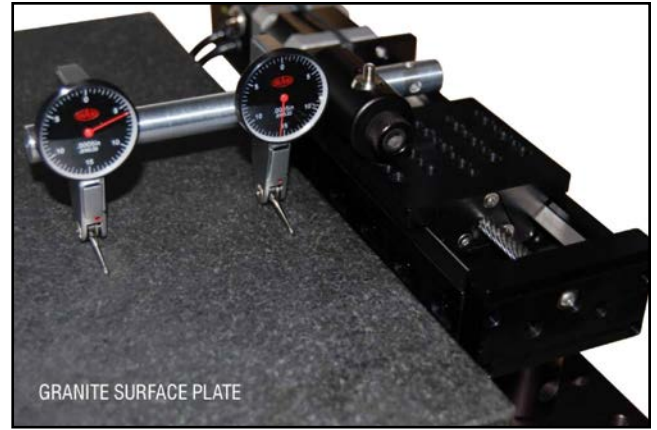


Figure 5 Setup for measuring Z error and roll error.

Measuring X error. The position error along the X axis is often referred to as "accuracy," but that is a misnomer since a larger value indicates a less accurate device.

This spec is almost always quoted by the manufacturer, so it is usually not necessary for the user to test it—which is fortunate, since it is the most difficult spec to measure without expensive equipment.

Figure 6 shows a typical setup for measuring the X error. A linear encoder is mounted and precisely aligned parallel to the X axis. The resolution of the encoder must be smaller than that of the motion control device you wish to test. In this case a Heidenhain MT 1271-length is used. It has a resolution of 0.05 μm . The linear slide in question has a relatively coarse lead screw and therefore its resolution is only one μm . It is helpful if the range of motion of the gage is greater than that of the motion device being tested, but this isn't strictly necessary, as it is possible to get a good idea of the position error over a relatively short distance. The gage in the image has a travel of only 12 mm while the linear slide has a range of 75 mm.



Figure 6 Setup for measuring X error.

Keen observers will note that as set up in the photo, the gage will be measuring a small component of pitch and yaw error, in addition to the X error. However, given the short range over which the X error is being measured, it is unlikely that the pitch and yaw angles will change significantly. Especially in open-loop, stepper motor-controlled systems, most of the position error along the axis of travel can be traced back to the motor itself. If your device uses a microstepping controller, you should be sure to look at positioning errors under three different scenarios:

1. Moving in single microsteps over at least four full steps.
2. Moving in full steps over at least one full revolution of the motor.
3. Moving in full revolutions over the range of the device (or your gage).

In motion systems based on bipolar stepper motors, there will be cyclic errors that repeat with periods of one step, four steps, and one full revolution. In addition, there will be error associated with the lead screw. The total position error at any given location within the range of travel is the sum of all these error components. Usually only the total error is quoted, but it is useful to have an idea of the amount of error contributed by each source, since some errors can be eliminated, for example, by moving in full steps — or full revolutions — of the motor.

Understanding the contribution from each source of error allows one to reasonably estimate the degree to which moving in full steps, or full revolutions, may improve performance.

Measuring repeatability. Repeatability specs, if quoted at all, are usually quoted only for the axis of travel. But any degree of freedom that has a position error also has repeatability. By performing the abovementioned position error measurement tests multiple times for the same setup, the repeatability of the X , Y , Z , yaw, pitch, and roll errors can be determined. Depending on the application, it may not be important that a linear motion system be very accurate; sometimes it need only be very repeatable. Typically, the repeatability of linear motion systems (especially stepper motor-based ones) is significantly better than their accuracy.

Measuring backlash. Like repeatability, backlash is usually quoted only for the axis of travel, but any degree of freedom that has a position error can also have backlash. In other words, approaching a location from one direction may result in a different error measurement than approaching the same location from the other direction. The difference between the two error measurements is the backlash, which is usually relatively constant over the full range of travel. Backlash may also be referred to as bi-directional repeatability and can be measured as one might expect — simply by approaching locations from either direction and comparing the results.

Measuring parallelism. All of the specs mentioned thus far are dynamic specs. That is, they are related to the motion of the device rather than to its static geometry. A device must be moved in order to measure a dynamic spec. Parallelism is one of the few static specs a user may be interested in measuring. While the pitch, yaw and roll errors are measures of the change in angular position as the slide moves through its range of travel, parallelism is a measure of the baseline from which those changes occur. Figure 7 shows a typical setup for measuring parallelism. A height gage mounted to a granite surface plate is used to measure the height of the stage surface at various locations. The parallelism is simply the variation in height. If desired, one can be more specific and quote parallelism in the X dimension (the variation in height from front to back) and parallelism in the Y dimension (the variation in height from side to side) as separate entities. But, typically, only a single value is quoted. Parallelism can be converted to an angle in radians simply by dividing by the appropriate dimension (length or width) of the stage surface.

Conclusion

Using relatively inexpensive equipment, it is possible to measure several important performance characteristics of a linear motion device. These measurement techniques are useful both for verifying specs quoted by the manufacturer and for determining specs that have not been quoted. **PTE**

For more information:

Zaber Technologies, Inc.
1777 West 75th Ave, 1st Floor
Vancouver, British Columbia
Canada, V6P 6P2
Phone: 1(888) 276-8033 (Toll Free Canada/USA)
1(604) 569-3780 (Direct)
Fax: 1(604) 648-8033
contact@zaber.com

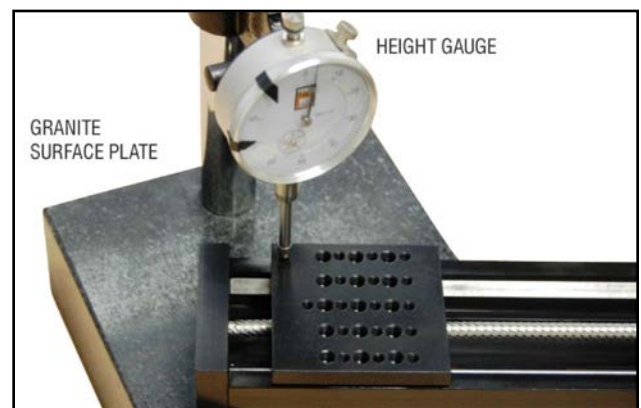


Figure 7 Setup for measuring parallelism.

Rob Steves, B.A.Sc., M.Eng. is an electromechanical design engineer and president of Zaber Technologies Inc., a manufacturer of stepper motor-based precision linear actuators, linear slides, and other motion control products used for optics, industrial automation, biomedical, and many other applications.

Global Industrial Outlook: the Ugly, the Bad and the Good

By Brian Langenberg, CFA

Global economic demand remains solid—even if you couldn't tell by recent third-quarter results and despite all efforts by U.S. politicians of both political parties. Let's go through what happened and what is coming.

The Ugly—third-quarter results, in general, along with mining, military and India. Let's start with earnings. We track about 50 global companies quarterly and provide deep-dive trend work to institutional investors and corporate executives. Going into 3Q—traditionally known as “confession season”—expectations were low; in fact, half the companies we track reported sales that were below consensus forecasts.

Since most of you are either in these markets or sell to them, you probably felt it. Every single machinery company we track missed revenue forecasts, as construction equipment markets saw continuing dealer inventory cuts, push outs and cancellations in mining, and weak stationary power generation markets. Conversely, Boeing did well thanks to commercial. However, military weakness continued and we believe could worsen beyond the expectations of your aerospace/defense OEM customer, *even if they are not yet sending you this signal*. India is awful; Cummins (CMI), for example, had a (25 percent) revenue decline—partly attributable to currency—but due primarily to weak and deteriorating conditions in truck (off 33 percent y/y) and power generation (34 percent) ex currency. Factor in a) political dysfunction as bad or worse than the U.S; b) elections are *next* year; and c) less wealth. And you shouldn't get your hopes up for a near-term rebound.

The Bad—U.S. short cycle industrial. In the U.S., concerns about sequestration, implementation of ObamaCare and budget clearly had a marginal impact on purchasing activ-

ity; the silver lining is that end market activity remains pretty good.

The Good—what got de-stocked in 3Q will likely get re-stocked in 4Q. The U.S. economy is still 65% consumer, and consumers, while having become perhaps structurally more frugal, are buying more cars and appliances and fixing their houses. Pull-through will happen. Europe has “improved” mathematically, which means easy comparisons—yet for all the talk about “Europe,” the reality is that Northern Europe and the Nordics—which is where the real money is—continue to grow. Middle East project activity is accelerating (good for Germany and the Nordics, power generation, construction equipment) and China orders for elevators (Otis, Kone Oy) indicate demand for construction equipment should continue to improve.

Oil & Gas: Activity remains pretty good—particularly upstream—and that should support capital investment going into 2014. One exception is the Permian Basin (primarily West Texas), as WTI oil price recently fell to \$96. Since the Permian news, the break-even oil price is highest in the U.S. (about \$70); a further oil price decline can hurt. Still, the overall picture remains strong. Worldwide, the dash for carbon in deeper, tougher, more inaccessible locations provides multi-year opportunities for growth and advanced applications.

Mining: New equipment orders continue to plunge, and we are even seeing delayed maintenance and equipment rebuilding activity. Expect continuing declines through next year. The worse-case scenario is that if all “unapproved” growth projects are canceled or delayed, we can see a further 30-35 percent decline through 2015.

U.S. coal in particular continues to see lay-offs in both mines and equipment. There is one bright spot—mine utilization remains high and therefore consumables and parts are holding up fairly well.

Power generation: The global demand growth for coal and gas continues to come from emerging markets—Middle East, China, Latin America. The U.S. is seeing delays and cancellations on new projects because of a) little need—conservation and green initiatives have materially affected demand growth, b) regulatory and political pressure—the president hates coal and gas pipelines; therefore the EPA does as well. Every utility earnings call we listened to echoed the same theme: no rate relief (revenue), no reason to build. The wind people benefit—which is helpful to you—as it is a no-brainer for a utility to throw up another wind turbine for \$2-4 million with no hassles. Going offshore demand for coal and gas powered generation remains strong and is turning into new orders and backlog, with major engineering and construction firms, as well as suppliers like Flowserve (FLS), which saw accelerating core orders and revenue of + 4 percent and + 6 percent, respectively.

Transportation infrastructure: In the U.S., figure no uptick before *late* 2015; that takes government funding, which can't possibly happen before a new Congress takes over that would want to write some checks. There is upside from improving residential housing prices. A boost in new homes and residential development could help on the margin. Europe may be improving—somewhat—off a low base. Atlas Copco (ATCO.B) reported *higher construction equipment orders in Europe*

Aside from indisputable facts and figures, the opinions and conclusions are the author's and do not necessarily reflect the position of Randall Publications LLC.

for the second straight quarter. Globally, passenger rail backlogs remain firm, if not really growing, at Bombardier (BBD.B) for new rolling stock (locomotives and passenger cars), while improving “low voltage” trends at ABB (ABB) are a positive outlook for 2014 and beyond (you have to lay the track and wire the system before you put the train on the track).

Water & Environmental: Municipal demand is primarily maintenance-driven, but we are seeing signs of higher interest in capital projects. We think the tone is improving with home prices – but real order growth is a couple years out. On the industrial side, de-watering and mobile equipment related to mining remain soft.

Machinery: The big picture continues to improve; *Construction equipment* production is moving toward “less bad” and sell through from distributors to end users was up y/y in 3Q. The worst is almost over for Caterpillar (CAT). *Mining equipment* is another story; we still expect a further decline of up to (20-30 percent) in spending over the next two years, and even worse on new equipment. *Truck:* U.S.—while full year Class 8 forecast has drifted downward, 3Q heavy truck shipments were up 7 percent y/y, driven by higher sales in North America and Brazil. China rose 26 percent, but that included pre-buy in front of higher NS4 environmental standards. *Agricultural equipment:* Our view remains unchanged. North America remains stable while John Deere growth investment emphasizes Brazil, China, India and Russia.

Consumer (auto, appliances): Good news continues—in the U.S., improving real estate prices are helping bolster consumer balance sheets, and thus pent up demand for durable goods. Automotive is proving to be persistently strong as evidenced by SKF’s improving revenue growth trends in its auto segment over the past ten quarters.

GE continued to show gains in appliances—partially from pent up demand and part share gain as GE benefits from actually reinvesting in new products. We expect continued growth in auto (both OEM and aftermarket

	OIL & GAS		MINING		POWER GEN		TRANSPORT		WATER & ENVIRON.		MACHINERY		CONSUMER Automotive Appliances			AEROSPACE/ DEFENSE	
	1.1	1.2	2.1	2.2	2.3	3.1	4.2	4.2.1	4.2.2	4.2.3	4.3						
OUTLOOK / CURRENT	<6M 12M	<6M 12M	<6M 12M	<6M 12M	<6M 12M	<6M 12M	<6M 12M	CURRENT			<6M 12M						
NORTH AMERICA	↗ ↘	↘ ↘	↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗	●	●	●	↗ ↗						
United States	↗ ↘	↘ ↘	↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗	●	●	●	↗ ↗						
Canada	↗ ↘	↘ ↘															
EUROPE		↘ ↘	↘ ↘	↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗						
ASIA, PACIFIC	↗ ↗	↘ ↘	↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗						
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MIDDLE EAST, AFRICA	↗ ↗		↗ ↗	↗ ↗	↗ ↗	↗ ↗	↗ ↗										

OUTLOOK: INDUSTRY VERTICAL
 <6 months (restock), 12 month (expansion, contraction).
 Multiple inputs - orders, sales momentum, macro and policy analysis.

TRENDS

- Strong ↑ = Anticipated orders/sales increase > 5%.
- Improving ↗ = Anticipated orders/sales increase 1-5%.
- Flat → = Anticipated orders/sales +1% to (1%).
- Slowing ↘ = Anticipated orders/sales down (1-5%).
- Weak ↘ = Anticipated orders/sales down (>5%).

service), appliances and housing. Expect the Fed to keep interest rates low at least through the November 2014 elections. European comparisons are now easier against a low basis, but we do not see any real pickup.

Aerospace/Defense: Boeing just announced a further boost in monthly 737 production; currently running at 38 units per month, but slated to rise to 47 by 2017 in their continuing battle with Airbus. (And speaking of Airbus, this just in: The news out of Paris is that EADS, parent company of Airbus, is “cutting 5,800 jobs over the next two years as part of a major overhaul to reduce costs and refocus on civil aviation.”

At the same time, cracks have emerged in the positive aerospace theme—not enough to change our mind, but it bears watching that freighter production is being cut amid weak demand and falling used aircraft values (AirCastle [AYR], a major air lessor, just took a write off against its 747 freighter fleet), regional orders have not yet happened, and the lower end of the business jet market remains weak. Aftermarket service and spares are improving—finally!—but we anticipate lower shop visit yield as fleet opera-

tors seek to do “just what they need to” on existing aircraft before taking those new deliveries that are driving aircraft engine production at GE and, eventually, UTX.

Military just continues to worsen, with no support from the president or either party in congress—even while China, Japan, and Korea continue to unveil and execute plans to increase their war fighting capabilities. Each of those countries will seek to source, as much as possible, from their domestic industrial base. And, by the way: *it can get worse.* Among other things, I am a member of the Navy League of the United States, which serves as an advocacy and support organization for maintaining our sea power. Having served on active duty during the build to 600 ships (we got to 571), there is now talk of going from slashing the fleet from only 285 ships now to 255 by 2020, and to include cutting total buy of Littoral Combat Ship from the 52 planned to 24 or 32—and even retiring an aircraft carrier early. No reason to think an F-35 can’t be cut or “pushed to the right.” The problem runs deeper than sequestration, which is temporary, and more toward gutting

our declining ability to sustain forward presence.

Capital spending—flat at best. Aerospace production rates are rising overall on the commercial side and under increasing pressure (overall defense) in military. On a net basis, call it positive. Construction equipment *should* improve; United Rentals (URI) is signaling a 5-10% increase in purchases in 2014, but you should think of that as “first-half-loaded” and the second-half as contingent upon what they see. An improving, non-residential construction market (projects are moving again in the Middle East, and the U.S. is improving slightly) are supportive because the first thing you have to do when putting up a new building is move some dirt.

Deal risk remains. Slow growth means “urge to merge” with big companies. Deal pricing is a bit higher, which can hold things in check. There is no time like the present to *think very hard about business risk.*

Supply chain concerns can be an opportunity. Not that it happens willingly, but large companies are concerned about deliverability. Honeywell, for example, suffered a \$100 million- plus revenue impact in its aerospace business this past quarter because of a vendor issue. The concept of “cheap vs. low cost” seems to resonate from time to time, so look for opportunities to supplant an offshore solution without giving away the store. What is slowly changing is “big customer” realization - particularly when safety or headline risks matter. Aerospace, oil and gas, would particularly lend themselves to this theme.

Focus Company: Cummins (CMI).

We selected Cummins because of its high-exposure, multiple end markets that use power transmission and gearing, including construction equipment, mining, truck, and stationary power. Shown below is

our revenue dashboard for Cummins over the past ten quarters.

Cummins continues to build strong global franchises for its engines and aftermarket business, bolstered by significant and extensive production and marketing joint venture relationships in China and India with key local truck and equipment manufacturers and engine producers. In the U.S. a strong R&D program and partnership with Navistar is helping to drive share gains, in addition to a strategy of gradually buying select distributors. The company missed 3Q forecasts and lowered guidance for this year, and particularly called out India as weak — and getting weaker. Mining is awful.

On the positive side:

Global truck demand remains solid, driven by both replacement activity and global GDP growth.

Construction equipment outlook is improving. While dealer inventory declined, sell-through in the U.S. was positive and globally there is an improved trend in non-residential construction activity that will translate into more equipment needs.

Our Integrated Company Dashboard (ICD) on CMI will give a better sense of these trends. These analyses are available on our website for \$199 but readers of *Power Transmission Engineering* magazine can email me directly at Brian@Langenberg-llc.com and ask for a copy by putting “PTE Offer” in the sub-

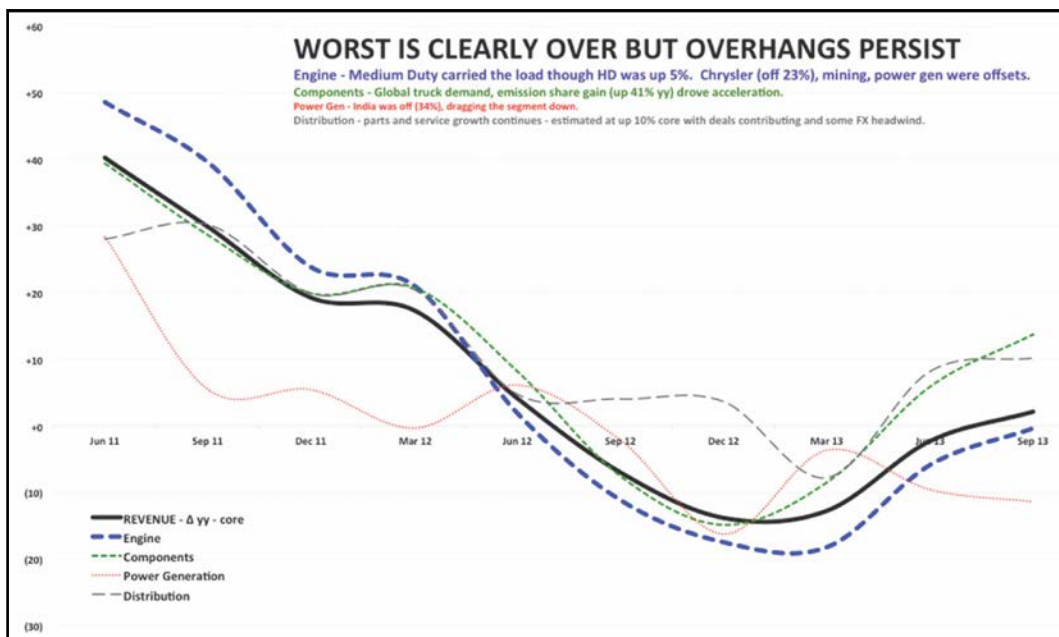
ject line. We expect CMI will continue to execute on its global growth strategies and playing ball with the company will likely require an understanding of how you can best support their desire to grow globally and capture the aftermarket gross profit around that OEM build.

European air and defense company EADS, the parent company of Airbus, said (12/9) it is cutting 5,800 jobs over the next two years as part of a major overhaul to reduce costs and refocus on civil aviation.

The company said in a statement that the jobs would be eliminated from its corporate and space and defense divisions by the end of 2016. The many space and defense divisions will be combined into one arm, to be called Airbus DS. **PTE**

Brian K. Langenberg, CFA,

has been recognized as a member of the Institutional Investor All-America Research Team, a *Wall Street Journal* All-Star, and *Forbes/Starmine* (#1 earnings estimator for industrials). Langenberg speaks and meets regularly with CEOs and senior executives of companies with over \$1 trillion in global revenue. His team publishes the *Quarterly Earnings Monitor/Survey*—gathering intelligence and global insight to support decision-making. You can reach him at Brian@Langenberg-llc.com or his website at www.Langenberg-LLC.com.



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5

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Should You Pay a Premium for a Mounted Ball Bearing?

Kyle Sobke, Baldor Electric Company

Mounted ball bearings are everywhere in industrial applications. They serve critical roles in keeping a manufacturing operation running smoothly and in ensuring that equipment functions properly and reliably. So why might it be advisable to spend significantly more for a dimensionally comparable bearing from one supplier versus another? These are commodity products, right? Is there really any difference from one mounted ball bearing to another?

Let's first address the notion of a mounted ball bearing being a commodity product. Components which offer little value and no differentiation in performance, like a steel bolt or a plastic hose, are considered commodities. However, if there is a marked difference in performance between like products, then by definition, those products are not commodities. If the features and benefits associated with one product afford a user longer life and better performance than with another product, the commodity nature of that particular offering has been removed from the equation. That is

the case with mounted ball bearings. Some last for a long time; some do not. Hence, they cannot be considered to be commodity products if there exists a difference in performance between offerings.

So what causes a difference in the length of time one mounted ball bearing lasts versus another? Bearings by nature are fatiguing components absent infinite life. At some point, all bearings wear down and must be replaced. Why does one out-perform another? Three primary factors affect the life of a mounted ball bearing in an application.

The most important predictor of the life of a bearing is how effectively an adequate level of clean, useable lubrication is maintained inside the bearing. Without effective lubricant, the bearing's balls and inner and outer ring raceways may not be fully separated, resulting in wear on the surfaces and leading to potential failure. This brings up the absolutely critical nature of sealing in a mounted ball bearing. In addition to ensuring a proper maintenance and lubrication sched-

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ule is employed, using a mounted ball bearing with effective seals is vital to keep liquid and solid contamination from entering a bearing and breaking down the lubricant. Seals also protect from the possibility of lubrication being washed out of a bearing. Another crucial component of bearing performance is the method for ensuring the seals stay in place. If a bearing employs mechanical seal retention, the seal is less likely to become dislodged during operation or relubrication. Seals held in place via elastomeric compression may become compromised as a result of heat or pressure associated with operation and may not stay in place. This situation is disastrous for a bearing. Finally, the use of a bearing end cover can help prevent contamination and grease loss. Higher quality bearings which feature effective end covers may prolong the life of the product. In the mounted ball bearing world, the better the seals and prevention of contamination, the longer the performance a user may expect.

Next, high quality, consistent and repeatable manufacturing processes also contribute to overall mounted ball bearing performance. The methods used to machine steel and iron before they are assembled into a finished product are critical to the life of the product, and they can vary greatly from one manufacturer to the next. Some of the most important machining factors are as follows:

- Surface finish of the inner and outer ring raceways – the smoother the surface of the mating components, the better the balls and inner and outer rings will run together. If a surface finish is not controlled through precise machining processes, heat, vibration, and self-contamination may occur. Industry standards typically stipulate a 4-Ra maximum surface finish. Values



The use of a bearing end cover can provide additional protection from the environment, preventing contamination and grease loss. A snap-on design may be easier to install than a bolt-on style.

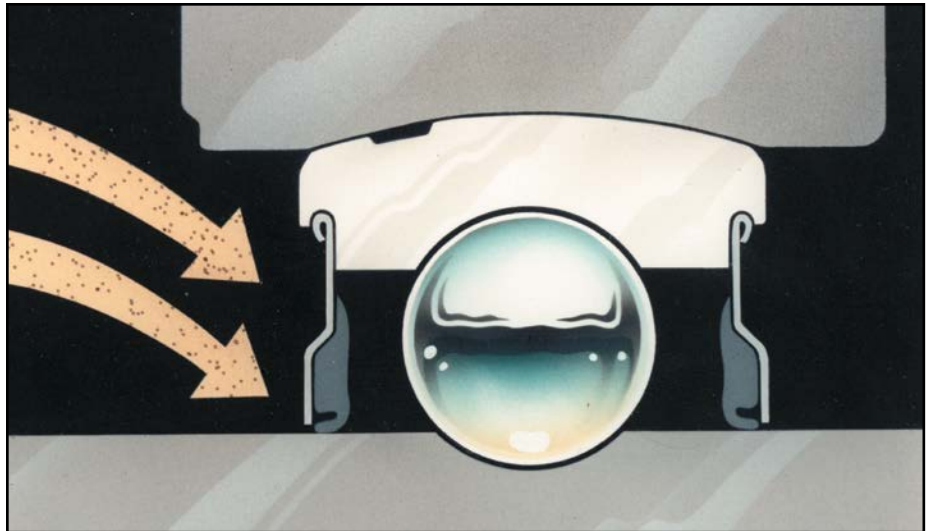
outside of this level may lead to premature failure.

- Radial clearance – the amount of space between the balls and the raceways must be within specification as well. Allow for too much movement, and excessive vibration is likely. Not enough clearance, and excessive heat generation can occur. As an example, the American Bearing Manufacturers Association specification for radial clearance of a 205 series mounted ball bearing (e.g., 1" bore size) is 0.0005" to 0.0011". Radial clearance values outside this range may lead to premature failure.
- Swivel torque – this measure represents the amount of force it takes to swivel the insert within the housing. Industry-based specifications for swivel torque for the same 205 series mounted ball bearing assembly are 3.75 to 13.5 foot-pounds. The inability of a bearing insert to align properly within the housing can stress the mounting structure and lead to unnecessary, compounding loads on the raceways that directly accelerate bearing fatigue. Once again, failure to control this dynamic is an indication of inadequate manufacturing processes and may lead to premature failure.

Manufacturers who control their processes tightly can ensure the parameters noted above are within specification, thus leading to a higher quality, longer performing bearing product. Those suppliers whose processes are not as sophisticated or regulated may have problems meeting the minimum



Bearing failures on this roll sizer machine were causing significant downtime at a Lamb Weston potato products plant. After installing a stainless steel mounted ball bearing with a superior sealing system that retains lubrication and prevents washout in wet environments, this machine went from being the least reliable to the most reliable.



Bearings that employ a mechanical seal retention, like the steel shield protection illustrated in this drawing, make it less likely that the seal will be dislodged during operation or relubrication.

requirements, and their products are destined for a shorter life span.

Finally, a third critical factor in mounted ball bearing performance is the quality of the heat treatment process the product undergoes. A manufacturing process with tight heat treatment controls is crucial to long-term bearing performance. Bearing steel under load in an application must exhibit the proper degree of hardness in order to perform adequately. There are a number of different materials and processes employed in the industry to achieve heat treatment results. To put it simply, though, mounted ball bearings need to be sufficiently hard in the raceways and sufficiently soft in other areas of the inner ring. Proper hardness in the raceways ensures the required load carrying capabilities. The inner and

outer rings must be hardened adequately in order to withstand the load associated with balls running at high speed while in operation. Other parts of the inner ring, however, must exhibit lower hardness values when compared to the raceways. If a set screw hole is too hard because of ineffective heat treatment methods, the steel may become brittle and have

the potential to crack when a set screw is tightened onto the shaft. Or, if a set screw hole is too soft, the set screws may loosen during operation. The heat treatment process must effectively account for growth or shrink of the materials in order to ensure dimensional tolerances are met. Improper heat treatment processes may affect a bearing's reliability and performance functionality prior to and after installation. This heat treatment balance is difficult to attain, and if a manufacturer does not have the right process controls in place, bearing performance will suffer as a result.

So what type of mounted ball bearing is right for a user's application? When does it make sense to pay two or three times as much for a product that can be purchased for a lower price? The answer is dependent on performance expectations. If a user wants a high quality mounted ball bearing solution which lasts and performs for an extended period of time, he probably needs to spend more up front. It will save money in the long run by preventing frequent failures; preventing excessive costs associated with downtime, maintenance and replacement; and preventing the potential for catastrophic failure and damage to more costly connected equipment. **PTE**

For more information:

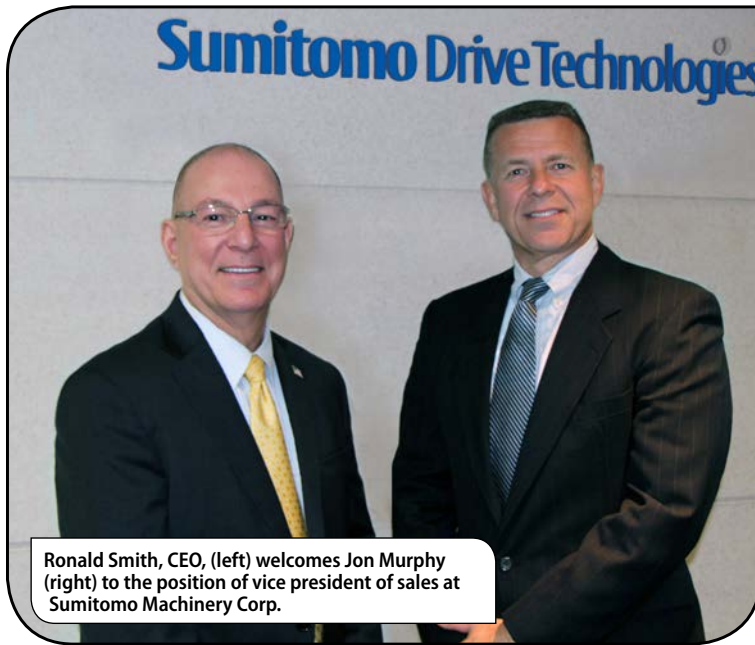
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Phone: (479) 646-4711
www.baldor.com

Sumitomo Machinery Corp.

ANNOUNCES PERSONNEL CHANGES

The U.S. headquarters for Sumitomo Drive Technologies, Sumitomo Machinery Corporation of America (SMA), headquartered in Chesapeake, Virginia, is pleased to welcome Jon Murphy to the executive management team as vice president of sales. Murphy will be responsible for leading the U.S. sales team, aftermarket, and customer service divisions of SMA.

Murphy graduated from West Virginia University with a Bachelor of Science in Petroleum Engineering and a Bachelor of Science in Mechanical Engineering. Murphy's career in the power transmission industry began with SMA in 1993, where he held the position of district sales manager. Expanding his knowledge and expertise in large industrial gearbox products, Murphy then spent four years at Rexnord as a drive specialist before rejoining SMA as a district sales manager again in 1998. Murphy quickly became a leader in sales and was promoted to corporate industry manager for the Eastern United States and Latin America, specializing in industrial gearbox power transmission solutions. Since 2010, Murphy has worked for SMA's parent company, Sumitomo Heavy Industries, Ltd. (SHI), based out of Tokyo, Japan, as global material handling manager, tasked to expand the gearbox business on a global scale. In his new position, Murphy will lead a team of over 50 highly skilled sales representatives and a strong network of authorized distributors.



Murphy stated, "Over the past 20 years, SMA and SHI have cared for me and my family. It is now an honor to accept this position and give back to others what has been given to me. SMA is the flagship company of the Sumitomo Drive Technologies brand. We represent the cutting edge of knowledge and innovation with industry-leading technology, experience and teamwork. In my tenure with Sumitomo Drive Technologies, I've made sales calls in 27 countries on six

continents, providing me a great understanding for the strategies that work and those that do not. I've been successful at developing partnerships and cooperation on a global level and plan to continue these strategies in my new leadership role here at SMA."

Ronald Smith, CEO and president of SMA, welcomes Murphy to the executive team, stating, "Jon Murphy is the epitome of our corporate values and has shown strong leadership, technical expertise and teamwork throughout his career with Sumitomo Drive Technologies. Jon's promotion to Vice President of Sales comes at the perfect time as we prepare for our next mid-term plan for 2014-2016. The knowledge and experience that he has gained working throughout the Western Hemisphere as well as other regions in the world will benefit the entire organization as we gear up for the future."

Additionally, Marcelo Kuramoto has been promoted to the position of managing director for Sumitomo Industries Pesadas do Brasil Ltda. Sumitomo's business in Brazil is optimized to provide a high level of customer intimacy by having a designated Sales Division in the city of São Paulo, SM Cyclo Redutores do Brasil, Com. Ltda. (SMBR), which focuses solely on sales and support to the customers while serving as a direct liaison with the SHIB factory. By designating customer support and manufacturing as two business divisions, Sumitomo is able to provide direct, quick and personalized support to our customers in the Brazilian market. Kuramoto will be responsible for managing the Itu manufacturing facility (SHIB) as well as continuing to lead the Brazil sales and customer service teams (SMBR), unifying the management of Sumitomo Drive Technologies' two business divisions in Brazil to bring the greatest value to our customers.

A native of São Paulo, Brazil, Kuramoto's rich background, fluency in Portuguese, Spanish and English, and his education in mechanical engineering and business administration have created a solid foundation for his international career in the power transmission industry. His career in power transmission began in 1992 working for a domestic company in Brazil in customer service and application engineering. In 1996, he started his career with SMA's subsidiary SMBR as a district sales manager in Brazil. Kuramoto quickly became a leader in sales and was promoted to sales manager and then general manager of SMBR. Expanding his success in South America, Kuramoto also held sales manager and general manager positions with SMBR's sister company, SM Cyclo de Chile, Ltda.(SMCH), before rejoining SMBR again as the general manager in 2010.

Other recent personnel moves at Sumitomo include Arthur Pantelides promoted to senior director of strategic planning and control in the United States, Michael Lulofs to senior director of human resources in the United States and Sara Zimmerman named director of business development in the United States.

PTDA

ANNOUNCES 2014 LEADERSHIP

The Power Transmission Distributors Association (PTDA) elected its 2014 Board of Directors and Manufacturer Council at the recent PTDA Industry Summit in Palm Desert, California. Ken Miko, director strategic accounts, BDI (Cleveland, Ohio) will become PTDA's president in 2014. He succeeds Chris Bursack, director marketing, ISC Companies, Inc. (Plymouth, Minn.). Miko has been active in PTDA since 1993, serving as a member of three committees (Educational Resources, Industry Relations and Technical Education) and most recently as first vice president, second vice president, and treasurer on the PTDA board. Miko also served as vice president of the PTDA Foundation in 2007, president in 2008 and 2009 and is currently an Industrial Careers Pathway Ambassador. "As PTDA's 2014 president, I now have an opportunity to lead our board as we continue to implement our strategic plan. We are working to influence the direction of our industry for the benefits of our distribution and manufacturer members, which is incredibly exciting and rewarding for me," said Miko.

Joining Miko on the 2014 PTDA Board of Directors will be:

- First Vice President Ajay Bajaj, president, Rotator Products Limited (Woodbridge, Ontario, Canada)
- Second Vice President LeRoy Burcroff, vice president sales, Bearing Service Inc. (Livonia, Mich.)
- Treasurer Mitch Bouchard, secretary & treasurer, General Bearing Service Inc. (Ottawa, Ontario, Canada)
- Immediate Past President Chris Bursack, director of marketing, ISC Companies, Inc. (Plymouth, Minn.)

Directors

- Bill Childers, president, C&U Americas (Plymouth, Mich.)
- Tom Clawser, director reliability services, Delta Reliability Div. Brown Transmission & Bearing Co. (Lancaster, Penn.)
- Harold Dunaway, executive vice president finance and administration, Motion Industries Inc. (Birmingham, Ala.)
- Jim Halverson, director PT & data communications, Van Meter Industrial (Cedar Rapids, Iowa)
- Carlton Harvey, vice president industrial sales & corporate quality, Jamaica Bearings Co., Inc. (New Hyde Park, N.Y.)
- David Mayer, vice president marketing & services, Kaman Industrial Technologies Corporation (Bloomfield, Conn.)

Brian Kolman, president, Brewer Machine & Gear Co. (St. Louis, Mo.), assumes the duties of the PTDA Manufacturer Council chair in 2014, succeeding Michael Dolpp, vice president sales Americas, Thomson Industries (Amherst, N.Y.). Kolman has served on the Council since 2009 and has been an active PTDA member for more than a dozen years. His committee involvement goes back to the year 2000 and includes service on the Marketing Committee. "I'm excited to be the next Manufacturer Council Chair for PTDA," said Kolman. "I can truly say you get the most out of PTDA by getting involved. The friends and business connections that I have made are invaluable."

Joining Kolman on the Manufacturer Council for 2014 will be:

- Vice Chair Cliff Bannon, eastern sales manager, Isostatic Industries Inc. (Chicago, Ill.)
- Immediate Past Chair Michael Dolpp, vice president sales Americas, Thomson Industries (Amherst, N.Y.)

Members

- Michael Cinquemani, president & CEO, Master Power Transmission (Greenville, S.C.)
- Chris Curran, president, Climax Metal Products Company (Mentor, Ohio)
- Chris Henson, director sales US distribution, The Timken Company (Canton, Ohio)
- Sean Hickey, president, Lafert North America (Mississauga, Ontario, Canada)
- Don Lanser, director marketing, U.S. Motors/Nidec Motor Corporation (St. Louis, Mo.)
- Tony Martell, vice president aftermarket business unit, NSK Americas (Ann Arbor, Mich.)
- Mike Power, director sales, Lovejoy Inc. (Downers Grove, Ill.)

ABB

REALIGNS EXECUTIVE COMMITTEE

ABB is realigning responsibilities in its Group Executive Committee (EC) to put a strong focus on acquisition integration and the significantly expanded North American business portfolio. Under these changes, **Greg Scheu**, who is currently responsible for marketing and customer solutions on the executive committee, will lead the group's acquisition integration efforts and take over responsibility for North America including the United States, ABB's largest geographical market. Scheu will retain responsibility for ABB's service business.



"Greg has proven to be a successful team-oriented leader in ABB's power and automation businesses in multiple divisional operating roles over many years. He has delivered strong results as the Baldor and Thomas & Betts integration leader, as well as in his current EC role responsible for marketing and customer solutions," said Chief Executive Officer Ulrich Spiesshofer.

"Greg's appointment to this realigned role on the EC signals our strong commitment to realizing the value of our acquisitions through best-in-class business integration, as well as to profitable growth in North America where ABB has made great progress in market presence and scale over the past years," he added. "Marketing and customer solutions has been an important organizational setup to get ABB to the next level of maturity and performance in cross-business collaboration and customer focus. It is now time to drive group-wide collaboration in a stronger business-led setup."

Scheu joined ABB in 2001 and has 29 years of experience in the power and automation industry, with a strong focus on

North America. He previously worked for Rockwell Automation and Westinghouse Electric. "I am very excited about the opportunity to lead ABB's North America business, global acquisition integration and service businesses," said Scheu. "I look forward to taking these important areas to the next level of profitable growth."

Enrique Santacana, currently country manager in the U.S. and regional manager in both the North and South America regions, will focus on profitable growth in South America.

Metallized Carbon

APPOINTS QUALITY ASSURANCE MANAGER

Roxanne Andrian will fill the position of quality assurance manager and will oversee the operations of the quality assurance department and ensure that all products produced are of the highest quality and comply with internal and external requirements. "We are delighted to have Roxanne join the Metcar team," says President and CEO, Matthew Brennan, "Her experience will ensure we can continue to produce the high quality products our customers have learned to expect."



Andrian holds a Ph.D. in mechanical engineering from the University of Montreal and has more than 13 years of experience in quality assurance in the aerospace, automotive, petrochemical, and oil and gas production industries. Furthermore, Andrian holds a certification as a Six Sigma "Master Black Belt." Her extensive QA expertise will be necessary to meet the high standards of Metallized Carbon's carbon-graphite products that are required to survive and function under the harshest conditions. In addition, Andrian is dedicated to promoting communication between employees and management, and is committed to lean manufacturing principles. In past roles she has helped her former companies significantly reduce waste and raw material needs and she hopes to continue this focus at Metallized Carbon.

REM-C

PROVIDES EDUCATIONAL BRIDGE FOR ROBOTICS AND ENGINEERING

REM-C, a university/industry partnership is pleased to announce its formation. REM-C (Roboticians, Engineers & Manufacturers Consortium) was established to bridge the gap between university robotic programs and the engineering community. REM-C is a non-profit organization, comprised of leading manufacturers and universities, dedicated to the advancement of robotic technology. The collective purpose of the membership is to inspire, innovate, identify technical challenges and provide engineered solutions to the robotics community. Founding members Fischer Connectors, Harmonic Drive, Igus and maxon precision motors have iden-



Roboticians, Engineers & Manufacturers Consortium

tified over one hundred and forty (140) universities, in the United States alone, with dedicated robotic curriculums. The costs associated with maintaining these technically challenging programs, at a high level, often times exceed the university budgets. REM-C provides universities a means for discount pricing, added technical support, networking, financial support, website forum and internship/employment opportunities. "It was not that long ago that artificial intelligence and advanced robotic research efforts were quietly housed in the back room skunk works of engineering giant and government sponsored agencies. The same high level of robotic technology is now being taught in the classrooms and developed in the laboratories of universities across the country," states REM-C Board President Kirk Barker.

ALCprecision

CHANGES NAME TO PRECIPART

Precipart Group, a global supplier of precision custom mechanical components, gears and motion control assemblies for medical technology, aerospace, homeland security and industrial markets, has changed the name of its ALCprecision operating company to Precipart. The name change coincides with the launch of a new Precipart informational website at www.precipart.com.

Based in Farmingdale, NY, the ALCprecision business unit provides custom solutions for high-precision machined parts, technical ceramic components, custom mechanical assemblies and miniature parts in various materials. Tracing its origin back to the mid-1800s and the invention of the Swiss Screw Machine, the company offers value-added services on a global basis — from design through high-volume production and delivery logistics.

The name change is effective immediately. However, the company's structure, ownership, processes, quality systems, staff and location will not change, according to Robert Marchese, Precipart president and CEO. "The name change from ALCprecision to Precipart correlates with the alignment of our operating companies in strategy and process under one common brand," explained Marchese. "Together, the Precipart Group family of companies is expanding its reach and capabilities beyond component production to offer added



PRECIPART®

value for its customers. Not only are we growing by providing systems and assemblies, but we see opportunities for growth and strategic sourcing in new geographic markets. The transition to a common brand identity is part of that vision for expansion.”

In addition to the name change and new website, Precipart is expanding its campus in New York, adding a new building with more than 21,000 square feet of manufacturing space. Precipart Group has operations in Farmingdale, NY; Lyss, Switzerland; and Hampshire, England.

Altra

ACQUIRES SVENDBORG BRAKES

Altra Holdings Inc. recently signed a definitive agreement to acquire the shares of Svendborg Brakes A/S and S.B. Patent Holding ApS (together “Svendborg”) for a cash consideration of 80.1 million euros, less the cash remaining on the balance sheet at close, which is payable upon completion of the acquisition. Altra intends to finance the transaction through a combination of European cash and additional borrowings under its credit agreement. “We are excited about the acquisition of Svendborg, which provides us with an established business with a leading brand, new technology and a presence in a number of new geographic regions,” said Carl Christenson, Altra’s president and CEO. “This acquisition presents a number of new cross-selling and cost synergy opportunities that will help drive our top-line and

bottom line growth in the next few years. As we have demonstrated in the past decade through several successful transactions, acquisitions are a key part of our growth strategy,” Christenson continued. “Our integration team has prepared a complete 100-day integration program, which will be managed full-time to ensure a successful combination of the two companies.”

GE Oil & Gas

SIGNS AGREEMENT TO ACQUIRE ALLEN GEARS

Expanding its presence in the industrial gears sector, GE Oil & Gas, recently announced it has signed an agreement to acquire Allen Gearing Solutions (Allen Gears), a privately held designer, manufacturer and service provider of gears for industrial and marine applications. The move comes two years after GE acquired a 35 percent minority interest in the business. Allen Gears employs approximately 160 people and has one manufacturing facility in Pershore, U.K.

Allen Gears produces high-speed, high-power gearing solutions specializing in “epicyclic” gears that are lighter, more compact and typically have a higher power density than more traditional parallel shaft gear systems. Epicyclic gears are desirable in industrial and marine applications that require smaller footprints. The U.K. firm has an installed base of more than 6,000 units worldwide with the vast majority being epicyclic gears. Currently, Allen Gears’ primary markets include Europe, the United States, Japan, Brazil, South

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Africa and South Korea with an emphasis on industrial segments including power generation, oil and gas, hydroelectric, marine and nuclear energy.

Allen Gears will be integrated into the Power Transmission division of GE's Texas-based Lufkin business, a leading supplier of artificial lift and industrial gears technology for the oil and gas industry. GE announced it completed the acquisition of Lufkin Industries on July 1, 2013. Lufkin's three power transmission production facilities and seven service centers manufacture industrial gears and engineered bearings, particularly parallel shaft gears that are designed to produce high and low speeds in turbine applications, predominately for energy-related industrial applications.

"This acquisition underscores the importance of Allen Gears' industry-leading technology and GE's ongoing commitment to grow all areas of our newly acquired Lufkin business," said Ian Milne, president of GE Oil & Gas' Lufkin division. "Bringing Allen Gears fully into GE will help Allen Gears grow by leveraging GE's global sales and service footprint."

"Allen Gears will add manufacturing and field service capacity, boosting GE's ability to compete for projects with tight production and delivery schedules," said Kevin Johnson, managing director of Allen Gears. "Our advanced technology combined with Lufkin's will also give us the ability to provide a more complete offering to customers."

Emerson Industrial Automation has appointed National Precision Bearing (NPB) an authorized distributor of McGill and Rollway aerospace and specialty bearings. The companies will focus on providing custom-made bearings to OEMs that supply pumps, gearboxes, rotors, generators and other components to the aerospace and defense industries, among others. "NPB is a well-respected aerospace and specialty bearing distributor with more direct sales representatives in the field than any other distributor we work with," said Emerson's Jeff Blackledge, director of international and domestic sales. "We believe there are significant incremental sales growth opportunities, particularly in OEM accounts and the government sector."

Emerson

APPOINTS NPB AS BEARING DISTRIBUTOR

NPB, a division of Mechatronics Corporation, specializes in precision bearing solutions for aerospace, defense, medical and industrial applications. The Preston, Washington-based company was originally formed in 1980 to support The Boeing Company and its subcontractors, and is AS9100 and ISO9001:2008 certified. According to Tom Koetje, marketing and business development manager for mechatronics, Emerson has the ability to handle the special requirements and short lead times common to the aerospace industry. "Emerson has demonstrated that it is a very capable niche supplier of specialty aerospace products, and we're confident that its quick turnaround capabilities on custom-made bearing solutions will create a number of new opportunities," said Koetje. "Both companies are focused 100 percent on customer success and Emerson's flexibility, responsiveness and engineering support will serve our customers well." McGill bearings have been approved by the top aerospace OEMs for more than 60 years, and the company has received recognition as a top supplier from many industry leaders. Bearing types include: cylindrical roller, needle roller, spherical roller, ball and roller sets. McGill and Rollway bearings are accredited for heat treatment, chemical processing and non-destructive testing by the National Aerospace and Defense Contractors Accreditation Program (Nadcap).

Moventas

REINTRODUCES SANTASALO BRAND

Moventas has reintroduced its legacy brand Santasalo as the brand for its industrial gears business. The Moventas Group, now renamed Santasalo Moventas, has two brands and business areas; Santasalo for industry and Moventas for new energy. Santasalo Moventas now reintroduces its long-standing brand Santasalo as the brand for its industrial gears business, industrial gearboxes and related after sales service: Santasalo - Geared for Industry and Santasalo Moventas - Geared for Service.

Santasalo is a major part of Santasalo Moventas' history since the 1940s and a trademark that the company owns. Moventas - Geared for New Energy, a recognised brand in the renewables industry, will remain as the brand for renewable energy technology, such as wind gearboxes, and related service. While reintroducing Santasalo, Moventas has also changed its group identity to Santasalo Moventas, to better reflect the two equally strong brands under its umbrella. Santasalo Moventas' legal structure remains, but its operational structure will be divided over this winter, to enable more flexibility in fulfilling customer needs on a global scale for both businesses.

Santasalo now has a new visual identity, strongly relating to the industrial audiences it serves. Both Santasalo and Moventas have launched new websites. New, separate brand sites enable a more user friendly and customer-focused approach than before, offering targeted, high-quality information for different customer industries.

CSIA

DISCUSSES AUTOMATION PROSPECTS IN 2014

An expansive U.S. economy and six months of overall manufacturing growth are generating optimism for the Control System Integrators Association (CSIA) as it prepares to meet the demands of industry clients in 2014. “The automation industry has benefited from a strong showing in manufacturing production and capacity utilization in 2013,” says **Piercarlo “PC” Romano**, CSIA board chairman. “Onshoring of high-tech manufacturing and inexpensive natural gas are two tailwinds that should help to extend the momentum for CSIA members into next year and beyond.” According to CSIA, automation is driving increased productivity as industry clients—from CEOs to plant engineers—have improved manufacturing within their existing facilities. Romano adds that CSIA integrator members expect the course of rebuilding and replacing older control systems to continue. “CSIA member companies provide the project management skills and execution systems required by our industry clients and are exclusively focused on delivering successful projects for them,” says Romano. “Today, more plant managers, directors of operations and others are engaging our integrators in larger and more diverse solutions to fit their automation needs.” In addition to expanding the influence of control system integrators, CSIA is developing online platforms and other products and services to increase value to CSIA’s membership and the industry at large. While the majority of CSIA’s integrator members are located in North America, Romano says CSIA forecasts significant growth prospects worldwide.



Rexnord

ACQUIRES PRECISION GEAR

Rexnord has announced that it has acquired Precision Gear Holdings. Precision Gear has two operating subsidiaries, Merit Gear LLC, located in Antigo, WI, and Precision Gear LLC, located in Twinsburg, OH. PGH employs approximately 190 associates and has annual net sales of approximately \$45 million. Merit Gear is a build-to-print manufacturer of high-quality gearing and specialized gearboxes primarily for the North American oil and gas market, along with other diversified industrial markets. “Merit’s capabilities and offering are highly complementary to our core Falk product line,” stated Dean Vlasak, Rexnord vice president, innovation and energy. “This acquisition presents the opportunity to enhance the value and breadth of solutions we can bring to Rexnord and Merit customers. Moreover, Merit strengthens Rexnord’s presence in key oil and gas markets and brings strong relationships with leading OEMs and drillers.”

Precision Gear is a manufacturer of highly specialized gears primarily serving the aerospace market, along with

various other industrial markets. “Precision Gear represents ongoing strategic investment into Rexnord’s aerospace product portfolio within its Process and Motion Control platform,” said Darryl Mayhorn, president, Rexnord Aerospace. “We are excited with this expansion of our aerospace gear manufacturing capabilities as well as the additional products and services the Precision team brings to better serve our existing customers.”

FANUC

MERGES ALL OPERATIONS INTO SINGLE CORPORATION

FANUC has officially merged all of its operations in the Americas into a single company named FANUC America Corporation. The new company, headquartered in Rochester Hills, Michigan will have combined annual sales in excess of \$1 billion. Rick Schneider, previously president of FANUC Robotics America has been appointed president and CEO of the new company. FANUC America Corporation will leverage the unique synergies made possible by this merger to better support its customers by supplying the most complete range of innovative products and services for robotics, CNC systems, and factory automation solutions in the industry. “The merger of the FANUC companies in the Americas better enables us to accomplish our mission of increasing the competitiveness of North and South American manufacturers by creating opportunities for them to maximize their efficiency, reliability, quality, and profitability,” said Schneider.

Beaver Aerospace

ANNOUNCES CONTRACTS WITH PARKER HANNIFIN

Beaver Aerospace & Defense, Inc., a subsidiary of Phillips Service Industries (PSI) and a designer and manufacturer of custom ball screws and broad-range actuation technologies, announced two new contracts recently with Parker Aerospace, a business segment of Parker Hannifin Corporation and a designer and manufacturer of flight control systems and other aerospace systems and components. According to the contracts, Beaver will supply horizontal stabilizer ball screw assemblies for the Bombardier Global 7000 and Bombardier Global 8000 ultra-long-range jets. Beaver will utilize high-strength stainless steel for the ball screw and ball nut to minimize corrosion as an alternative to chrome plating.

“Beaver Aerospace & Defense is proud to be selected by Parker Aerospace for this exciting opportunity,” said Ben Kearns, general manager of Beaver Aerospace & Defense. “Our industry-leading on-time delivery record, engineering expertise and willingness to help Parker achieve its key business objective were instrumental in securing both contracts.”

Beaver’s award-winning ball screws, electromechanical actuators, ball splines and gears can fit virtually any application, and are known throughout the industry for their reliable quality, precision and performance. As a certified FAA Repair Station, Beaver also offers expert repair, overhaul and testing services for all ball screws and electromechanical actuators.

February 10–12 — Gear Materials: Selection, Metallurgy, Heat Treatment and Quality Control.

Sheraton Sand Key Hotel, Clearwater Beach, Florida. The presenters have designed gear systems as a collaborative effort, together, for more than 40 years. This seminar is their effort to convey both their experience in the process of working as a team and the expertise they have developed for the complete design of geared systems over these many years. Instructed by Raymond Drago and Roy Cunningham from Drive Systems Technology, this course will cover material selection, heat treating processes, engineering development, inspection and more. Gear design engineers, management, metallurgists, lab techs, QA engineers, furnace design engineers and equipment suppliers would benefit from the course work. For more information, visit www.agma.org.

February 25–27 — AeroDef Manufacturing 2014.

Long Beach, California. AeroDef Manufacturing is the leading technical summit and exposition for the aerospace and defense manufacturing industry. Produced by SME, in partnership with industry OEMs, its mission is to foster innovation across the extended enterprise to reduce costs, expedite production times and maintain manufacturing competitiveness in the global economy. AeroDef showcases the industry's most advanced technologies across an innovative floor plan designed to facilitate interaction and business relationships between exhibitors and buyers looking for integrated solutions. Keynote speakers and panelists come from the highest level of government and business and will discuss topics on 3-D manufacturing, cybersecurity, workforce development, globalization and innovation. AeroDef's show floor is divided into Technology Zones reflecting the entire manufacturing enterprise – from design to manufacture to sustainability. At the center of it all is The Deck – the hub of the expo show floor and host to morning keynote presentations, daytime panel discussions, and afternoon networking receptions. For more information, visit www.aerodefevent.com.

February 27–March 1 — IPTEX 2014.

Bombay Exhibition Center, Mumbai, India. The 3rd International Power Transmission Expo is dedicated to the gear and power transmission industries. India is rapidly turning into a global manufacturing hub, thanks to the country's manufacturing and engineering capabilities, vast pool of skilled expertise and its size. These qualities offer it a strategic advantage for the manufacturing segment. A large number of international companies in varied segments have already set up a manufacturing base in India and others are following suit. Exhibitors include those involved in gear processing equipment, cutting tools, gear inspection and testing instruments, chains and belt drives. Key participants include Gleason

and Klingelberg. IPTEX is supported by the AGMA and its media partner is *Gear Technology India*. GRINDEX, an exposition on grinding and finishing processes, will run concurrently with IPTEX. GRINDEX is designed to meet the emerging demand for precision driven applications as manufacturing needs new technology and solutions. For more information, visit www.iptexpo.com.

March 4–8 — IFPE 2014.

Las Vegas, Nevada. IFPE is the leading international exposition and technical conference dedicated to the integration of fluid power with other technologies for power transmission and motion control applications. Held every three years, the exposition showcases the newest innovations and expertise. The event includes more than 400 exhibitors, product concentration areas, more than 100 education sessions, keynote presentations, college-level courses in hydraulics and pneumatics. Technologies and products include aerospace, energy, automation, material handling, off-highway, fluid power, power transmission and more. IFPE 2014 is co-located with CONEXPO-CON/AGG 2014, the largest international gathering place for the construction industries. For more information, visit www.ifpe.com.

March 5–6 — Lean Transformation Summit 2014.

Orlando, Florida. Continuously improving management systems allow companies to provide better quality, more reliable delivery, better service and lower costs. The summit provides attendees with relevant, real-world learning sessions to enhance their lean efforts. Plenary sessions offer feedback from organizations that have developed successful lean programs including Cardinal Health, Food Bank for New York City and GE. Breakout sessions follow that give a firsthand account of the challenges faced during the lean transformation. Additionally, small interactive learning sessions allow attendees to reflect on applications and methodologies on the leading edge of lean thinking. For more information, visit www.lean.org.

March 11–13 — Gearbox CSI: Forensic Analysis of Gear and Bearing Failures.

Sheraton Suites, Philadelphia Airport, Philadelphia. Determining the cause of a failure in a gearbox is like a "who done it" mystery. What caused the failure? The bearings, a gear, the lubrication or a shaft problem? Where do you start, and how can you tell? This seminar helps gear designers gain a better understanding of various types of gears and bearings. Learn about the limitations and capabilities of rolling element bearings and the gears that they support so you can properly apply the best gear-bearing combination to any gearbox, whether simple or complex. A certificate will be awarded upon completion of the seminar. For more information, visit www.agma.org.



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A Mechanical Mélange of Art, Movement, and “Memory”

For many, the word “automaton” resonates with 1950s pulp science fiction or Rod Serling’s *The Twilight Zone*. But for centuries — A.D. — and B.C. — the world of automata was one of high-brow wonder and mystery for folks with disposable income — or royals with too much time on their hands.

Like many words, automaton is Latinized from the Greek, and is usually used to describe non-electronic moving machines. Fittingly, there are many examples of automata in Greek mythology: Hephaestus created automata for his workshop (the first Roomba, maybe?); Talos was an artificial man of bronze; etc.

Automata in the Hellenistic world were intended as toys, religious idols, or tools for demonstrating basic scientific principles, including those built by Greek mathematician Hero of Alexandria (sometimes known as Heron).

It was the dawning of the Renaissance that inspired new interest in automata. Giovanni Fontana created mechanical “devils” and rocket-propelled animal automata. These wondrous devices found a home in the “cabinet of curiosities” or *wunderkammern* of the princely courts of Europe. Hydraulic and pneumatic automata were created for garden grottoes. Absolutely no one should be surprised that Leonardo da Vinci sketched a more complex automaton around the year 1495. The design of Leonardo’s “robot” was not rediscovered until the 1950s.

Moving on, we find a new — if not bizarrely creepy — attitude towards automata attributed to 17th century philosopher Renè Descartes, who held that the bodies of animals are nothing more than complex machines — and that the bones, muscles and organs could be replaced with cogs, pistons and cams.

At any rate, 17th century France was the birthplace of those ingenious mechanical toys that were to become prototypes for the engines of the Indus-

trial Revolution. Indeed, in 1649, when Louis XIV was still in culottes, an artisan named Camus designed for him a miniature coach and horses — complete with footmen, page and a lady within the coach; and all these figures exhibited perfect movement.

And then there is Henri Maillardet, a Swiss mechanic of the 18th century, who worked in London producing clocks and other mechanisms. He designed and built the Draughtsman/Writer — an exquisite toy for adults (please don’t go there; this is a family magazine) around 1800, and it possesses the largest “mechanical memory” of any such machine ever constructed — four drawings and three poems are “his” legacy (two in French, one in English). The mechanism is a perfect example of our desire for not only making things move in a mechanical yet artfully expressed way — but for watching them as well. It is a combination that seems to appeal to many — visually and viscerally. Think hand-cranked motion pictures.

But by the time the poor guy was donated to The Franklin Institute in Philadelphia, it had been virtually destroyed in a fire and hadn’t operated for years. However, an institute machinist began tinkering with the automaton and eventually had it functioning. It was displayed occasionally in The Franklin for the rest of the 1800s.

“The heart of the automaton’s writing and drawing operation is actually a mechanical ‘read only memory’ in the form of an array of disk cams rotating on a common shaft to drive the right hand of the figure,” according to The Franklin Institute website. “The information contained in the undulations of the selected set of cams is picked up by three cam followers linked to the doll’s hand to produce the required left-and-right, up-and-down, and vertical move-

ments. Maillardet’s automaton contains a total of 72 operating cams that control the movements of the right hand. Additional and far simpler cams move the left hand, head and eyes of the doll.”

As recollected by an institute employee in 1928, the “boy” was in a tattered uniform that looked to him to be that of a French soldier. As the boy’s legs were either missing or beyond repair, it was decided for some reason to dress him as an 18th century woman in a long dress. Perhaps the wardrobe switch was just an example of the “French being French,” but in 1826 a lithograph was found, with captions, and voila! — it is proved that the automaton is in fact a boy.

Today, however, he — she — what-



Henri Maillardet’s automaton contains a total of 72 operating cams that control the movements of the right hand. Additional and far simpler cams move the left hand, head and eyes of the doll (photo courtesy The Franklin Institute).

ever — is presented au naturel to better display the inner workings of this mechanical wonder. (*For a richer, online automaton experience, replete with videos, photos, and history, go to www2.fi.edu.*) **PTE**

For more information:

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(Sources: Wikipedia and The Franklin Institute.)

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