August 2010

PTE

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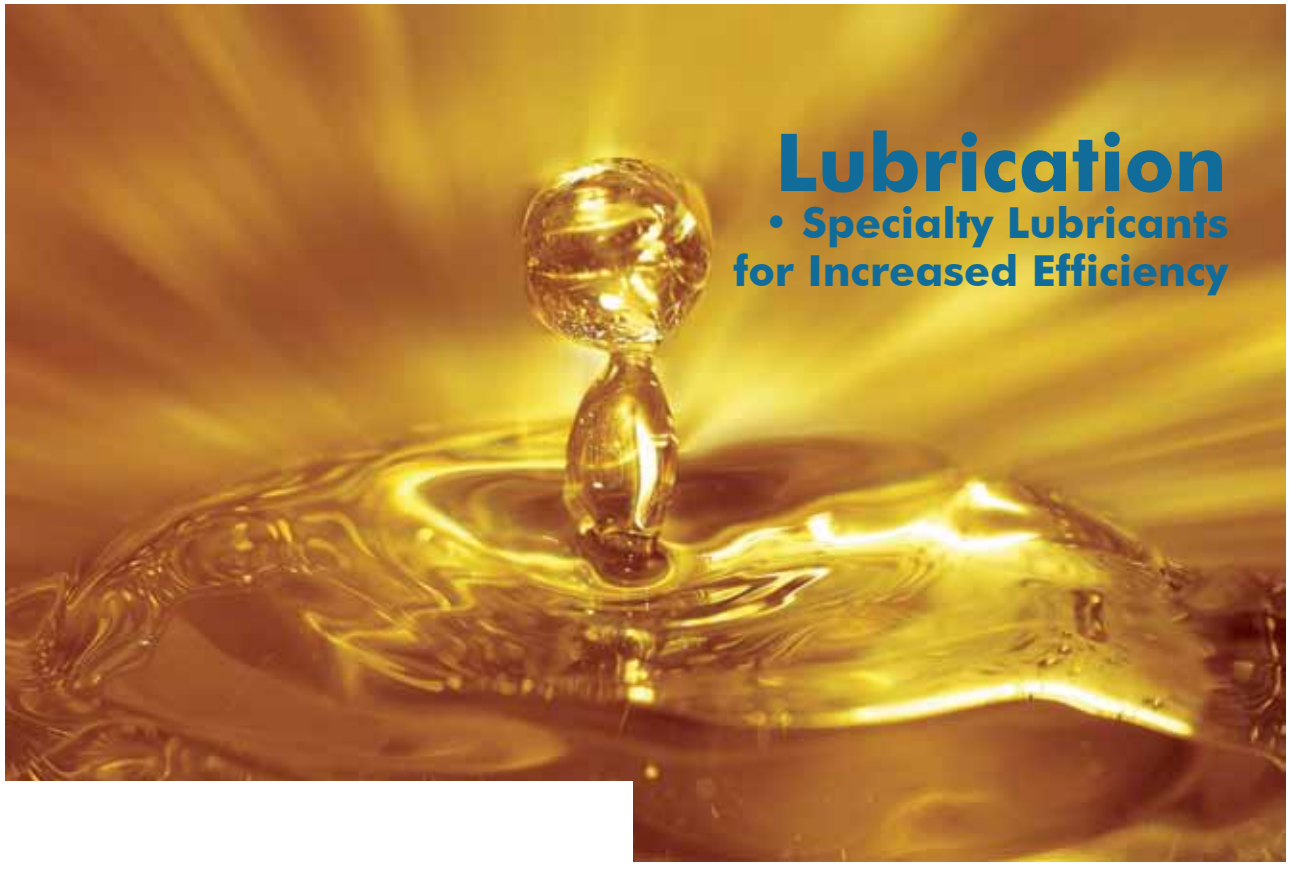
Features

- Gear Drives in Centrifuge Applications
- Position Sensors for Power Transmission Feedback
- Energy Efficient Bearings
- Hollow Shaft Torque Motors



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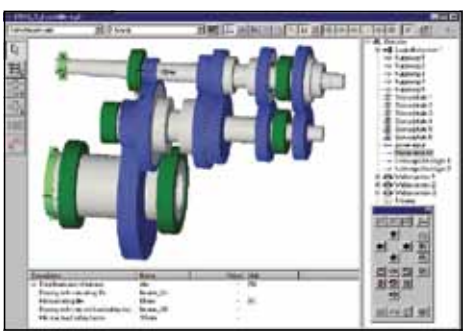

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Who says you can't be all things to all people? Well, we suppose the size of our machining centers is a limit, if you can call what you see here limited?

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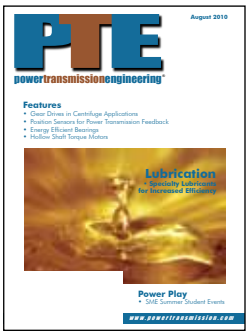

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Parker Motor

POWERS BRAMMO'S NEW ELECTRIC RACE BIKE

MPP series traction motors from Parker's Electromechanical Automation Division power an all-electric motorcycle built by Brammo Inc. The bike is built for speed and was recently unveiled at the Red Bull U.S. Grand Prix at the Mazda Raceway in Laguna Seca, CA, where a major race took place as part of the FIM e-power race series. It was the perfect venue to display the bike's sleek lines and spark the interest of competitors and enthusiasts alike.

"The Brammo engineering team has been an exceptional group to work with," says Jay Schultz, Parker product manager. "They exemplify what high-performance engineering is all about, which parallels Parker's commitment to engineering our customers' success. And it shows in this bike."

Designed for the demanding applications found in today's high-performance electric and hybrid vehicles, Parker's MPP traction motors offer lower weight and higher power, all in a smaller package than other traction motors. Parker's MPP motors include Parker's exclusive dual-cooling implementation, which features a patent-pending internal cooling technology. According to Parker's press release, this design yields up to 40 percent higher torque per unit size than conventionally constructed permanent magnet motors and can deliver 20–350 kW of power with 97 percent efficiency.

When the bike makes its racing debut in September, leaders in the racing circuit will have a serious new contender vying to capture the winning trophy. Brammo plans to market a street version of the race bike for the commercial market next year. Brammo and Parker are working through the details around a smaller MPP motor for the production version.

"Working with Parker has been an outstanding, positive experience," says Roger Gerson, Brammo's electrical engineering manager. Gerson and his team designed the gear-reduction enclosure that houses the MPP motor, working closely with Parker in a very compressed timeframe. "We've leveraged Parker's leading-edge R&D work and stretched it to the max."

For more information:

Parker Electromechanical Automation
5500 Business Park Drive
Rohnert Park, CA 94928
Phone: (800) 358-9068
www.parkermotion.com

Brammo Inc.
550 Clover Lane
Ashland, OR 97520
Phone: (541) 482-9555
www.brammo.com

Bearing Units Self-Align

The ready-to-mount bearing units from NKE consist of a bearing fitted in a cast or pressed housing for material handling systems, such as conveyors, as well as applications in the heavy and agricultural machinery and steel industries.

The bearing unit's housings can be combined with a range of bearing inserts. The cast iron housings are resistant to deformation and can absorb moderate to high loads. The pressed sheet steel housing models are suited

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US 7,421,929 B2 patent granted, other patents pending worldwide

EXAMPLE
MGT planetary magnetic gear box

for applications with lower loads due to their lower weight and simpler installation.

The bearing inserts consist of single-row deep groove ball bearings that are sealed on both sides against moisture, splash water and dust. Various seal types are available for different applications. The bearings are secured to the shaft with set screws or eccentric locking collars, which simplifies the installation. The bearings are factory lubricated and most bearing-housing combinations can be re-lubricated during operation to extend service life. The special version SQ171 is coated for enhanced corrosion protection.

The spherical design of the bearings' outer diameters and the housings' inner diameter enable the units to self-align, so any misalignments that occur during installation or operation are compensated. NKE's bearing units are interchangeable with products from leading manufacturers.

For more information:
NKE Austria GmbH
Im Stadtgut C4
4407 Steyr
Austria
Phone: +(43) 7252-86667
Fax: +(43) 7252-86667-59
www.nke.at

Plastic Shaft Collars

MATCH PROCESSING REQUIREMENTS

Custom shaft collars machined from various thermoplastics to match process applications requiring chemical resistance and frequent washdowns are available from Stafford Manufacturing Corp.

The Stafford plastic clamp-type shaft collars are offered in one- and two-piece styles and are supplied with stainless steel clamping screws for use in FDA- and USDA-approved processing equipment and conveyors. They are machined from Teflon, Delrin, nylon and other thermoplastics, so designers can specify collars that precisely match other system components.

Available in one to four-inch ID bore sizes, the plastic clamp-type shaft collars are appropriate for applications such as food and pharmaceutical processing. Stainless steel, steel and anodized aluminium collars are also available.

The plastic clamp-type shaft collars are priced according to material, size and quantity. Samples and price quotations are available on request.

For more information:
Stafford Manufacturing Corporation
P.O. Box 277
North Reading, MA 01864
Phone: (800) 695-5551
Fax: (978) 657-4731
www.staffordmfg.com

New Higher Torque Magnetic Particle Brakes

Ogura has developed two new models of the OPB series of magnetic particle brakes. The two new models, OPB 120N and OPB 250N, are rated at 110 in.-lbs. and 220 in.-lbs. respectively. The largest previous model in the OPB series was rated at 70 in.-lbs.

Heat dissipation of the 120N is 80 watts and heat dissipation of the 250N is 100 watts, but both brakes will have an optional mounted fan to increase heat dissipation to 200 watts and 240 watts, respectively. Although the brakes are mainly used for tension control of foil, film, wire and paper, there are many other industrial applications where soft stops can be of benefit. Since output torque is almost directly proportional to input voltage/current, torque can be controlled very quickly and accurately. For example, a conveyor system conveying a delicate or sensitive product would require a controlled stop to avoid damage. The new brakes are designed to be less costly than the old PB series and will be more readily available.

All Ogura manufacturing facilities are ISO recognized and conform to the ISO 9001;2008, ISO 140001, and ISO/TS 16949 standards.

For more information:
Ogura Industrial Corp.
P.O. Box 5790
Somerset, NJ 08875
Phone: (732) 271-7361
www.ogura-clutch.com

Vertical Lift Stage

OFFERS 2 NM RESOLUTION

Aerotech's ANT130-5-V is a linear-motor-driven wedge-style vertical lift stage that provides the resolution, accuracy and in-position stability required in nanopositioning applications, all while offering travel up to 5 mm. It is a precision stage that is suitable for industrial applications. The ANT130-5-V was designed for stand-alone use or can be integrated with other stages in the Aerotech ANT stage family for a multi-axis nanopositioning system.

ANT130-5-V stages utilize advanced direct-drive technology, pioneered by Aerotech, as well as anti-creep crossed-roller bearings for positioning performance. Aerotech direct-drive technology is non-cogging, non-contact, high-speed, high-resolution, and high-accuracy. The lack of hysteresis or backlash enables accurate and repeatable nanometer motion. The drive and bearing combination, packaged in a compact profile and footprint, offers tangible advantages in high-precision positioning applications such as disk-drive fabrication, fiber alignment, optical delay element actuation, sensor testing, and scanning processes that demand smooth, precise, stable, and repeatable motion.

The ANT130-5-V family has universal mounting and tabletop patterns that allow for easy system integration. Two, three or more axes can be easily combined for flexible system designs and multi-axis configurations.

Outstanding accuracy, position repeatability, and in-position stability require high system resolution. The ANT130-5-V stage provides 2 nm minimum incremental step size. The ANT130-5-V series data sheet is available at: *http://www.aerotech.com/products/NANO/ant1305v.html*.

For more information:
Aerotech Inc.
Phone: (412) 967-6854
smclane@aerotech.com
www.aerotech.com

DC Gearmotor

DEVELOPS 214 LB.-IN. TORQUE AT 23 RPM

Midwest Motion Products announced the release of a new DC gearmotor, the Model No. MMP-TM57-12V GP52-195. Accepting any 12-volt DC source, including battery power, this gearmotor measures just 2.24" diameter by 7.75" long, and has a keyed output shaft of 12 mm diameter by 25 mm long. Easy mounting is accomplished with four face-mount M5 threaded holes. The output of this reversible gearmotor is rated for 214 lb.-in. continuous torque at 23 RPM and 443 lb.-in. peak torque. Despite its compact size and weight of approximately four pounds, it requires just 7.2 amps at 12 volts DC to generate its full-load torque. That translates into long life battery charge, very low noise

continued

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operation, and lower costs for related drive electronics. Motor windings for 24, 28, 36, 48, 60 and 90 volts are available. This design is rated at an IP 54 protection level for operation in harsh environments. Variable Speed can be accomplished with MMP's fully compatible speed controls, Model MMP 25A-12V or MMP 20A-12V-RSP.

Samples are available from stock for rapid prototyping needs. An up-to-date listing of finished products available from stock can be found at *http://www.midwestmotion.com/inventory.pdf*.

For more information:
Midwest Motion Products
10761 Ahern Avenue SE
Watertown, MN 55388
Phone: (952) 955-2626
Fax: (480) 247-4096
engineering@midwestmotion.com

Modulated Hydraulic Pressure Source

CONTROLS BRAKE TORQUE

The 520 Series hydraulic apply caliper disc brake for on- and off-highway service braking applications uses a modulated hydraulic pressure source, such as a master cylinder, to control brake torque. The brake can be mounted in a vertical or horizontal position, and linings can be replaced without removing the brake.

The brake includes two ductile iron caliper halves that are pressurized by a single inlet port cross-over tube feature, which allows hydraulic pressure to actuate the 2.25-inch diameter piston in each half. The unit provides for continuous duty pressure of 1,000 psi and intermittent duty pressure of 1,500 psi. Approximately 17 pounds, the brake needs a minimum disc diameter of 15 inches.

The caliper disc brake features a spring-operated lining retractor mechanism that maintains a constant lining-to-rotor disc clearance distance whenever the brake is not applied to reduce unnecessary lining wear. The lining contact area totals 12.4 square inches, with a usable lining thickness of 0.32 inches on each side. Linings can be replaced without disassembling or removing the brake for reduced maintenance time and costs.

Mounting in either a horizontal or vertical position, the brake is flexible and installs simply. The unit can be attached directly to a threaded hanger or clamp.

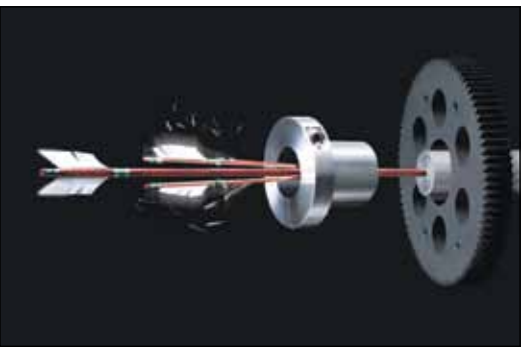
For more information:
Mico Incorporated
1911 Lee Boulevard
North Mankato, MN 56003
Phone: (507) 625-6426
Fax: (507) 625-3212
micomail@mico.com
www.mico.com

Shaft-Locking Bushings

PROVIDE HIGHER CONCENTRICITY FOR GEARS, PULLEYS AND SPROCKETS

ETP shaft locking bushings from Zero-Max produce accurate and concentric mounting compared to mechanical shaft locking bushings.

ETP bushings incorporate a double-walled sleeve encapsulating a pressure medium. When the actuation screw is tightened, it forces the inner and outer wall of the bushing to expand uniformly against the shaft and hub of the mounted component. The result is concentricity to .001" total indicated runout (TIR). Mechanical devices, by comparison, rely on precise and accu-



rate tightening of the actuation screws to avoid excessive TIR. Additionally, extremely high compressive forces are imparted on the shaft by mechanical bushings.

ETP bushings are designed for applications in which repeated mounting and dismantling of components is required. The ETP Classic has flange-mounted actuation screws. The ETP Express has just one mounting screw positioned in a radial location, allowing for fast, easy and accurate mounting of components. The single actuation screw saves space, time and is easy to access.

Both ETP Classic and ETP Express operate in temperature ranges from –22 degrees to 180 degrees F.

The ETP Classic handles torque ranges from 40 to 11,413 ft.-lbs. while the ETP Express handles torque ranges from 40 to 6,400 ft.-lbs. Both require no lubrication. They are available in a full range of inch and metric sizes in both standard steel and stainless steel.

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Safety Clutch

INCORPORATES SENSOR
WITH SIGNAL TRANSMITTER

Safety clutches provide precise torque limiting to ensure that the loads on components in machines and facilities do not exceed allowable levels. Up to now they have required an external limit switch and associated cable to send a signal to the controller if an overload situation occurred. The new EAS-Sensor safety clutch with integrated signal transmitter developed by Mayr Antriebstechnik sends the overload signal wirelessly. This has considerable advantages compared with conventional signal transmission.

The stroke of a safety clutch when it disengages due to excessive torque is only a few millimeters. This small amount of travel is all that is available to change the state of a built-in mechanical or contactless limit switch. Consequently, external limit switches must be fitted and adjusted precisely and with great care to ensure that they operate reliably. However, under certain conditions, even the greatest possible care is in vain, for example when the position of the safety clutch shifts during operation as a result of thermal expansion.

With the new EAS-Sensor, the limit switch is integrated directly in the clutch. It detects the disengagement motion of the clutch in case of overload and transmits the signal wirelessly to a base station connected to the machine controller. The EAS-Sensor is adjusted in the factory for proper operation, eliminating the need for assembly and adjustment effort. External factors such as vibration or axial offset of the clutch, which may result from thermal expansion of the shaft, do not impair operational reliability.

The transmitter of the new unit, including its power supply, is entirely contained in the torque adjustment nut of the EAS-compact safety clutch. It reports the operating state of the clutch at regular, short intervals, along with information on the supply voltage level. If the supply voltage drops, a warning signal is triggered early enough to allow the transmitter battery to be replaced promptly. This does not require dismounting the clutch.

The new EAS-Sensor is better than conventional safety clutches with external limit switches, especially in the following application scenarios. In the case of drives with moving shafts, such as robot arms, it is not necessary to move brackets and cable guides along with the drives. This makes the entire assembly significantly simpler and more reliable. Reliable signal transmission is also ensured with drives subjected to vibration or horizontal motion. Axial offset of the clutch, for example as a result of the thermal expansion of the shaft, can easily lead to false triggering in conventional systems with externally fitted signal transmitters. Naturally, the EAS-Sensor is an option for applications where there is simply no room to fit an external limit switch. In addition, the new device is an option when drives must be installed on site. It is ready to install out of the box.

For more information:
Mayr Corporation
4 North Street
Waldwick, NJ 07463
Phone: (201) 445-7210
Fax: (201) 445-8019
info@mayrcorp.com
www.mayrcorp.com

New Linear Actuators

OFFER COMPACT SIZE &
DUST/WATER PROTECTION

Nook Industries has recently introduced its NIA Acme and Ball Screw Series linear actuators that offer compact size configuration and protection against solid (dust, airborne particles,

etc.) and liquid (rain, water spray, etc.) elements. This cost-efficient series is designed for light-duty indoor/outdoor applications.

All of the NIA Series linear actuators are designed to deliver IP54 protection against dust or water intrusion as a standard. They are also offered with IP65 protection as an option. Design elements contributing to these high IP ratings include a steel extension tube, powder metallurgy gears and an aluminum alloy housing.

The NIA Series offers a standard 110/115/230 VAC single-phase split capacitive motor that delivers a 25 percent duty cycle. There is no need to purchase an external capacitor because it is supplied. Other standard performance characteristics for both acme and ball screw versions include dynamic load capacity of 1,500 lbs. and less, stroke lengths from 4" to 24", working temp. of –26 degrees C to +65 degrees C, self-locking, and overload protection by clutch. Optional potentiometer feedback and adjustable limit switches are also available to extend added-value for unique applications on both versions.

Nook also offers its ND8 Ball Screw Series as a 12/24V DC Motor option that delivers the same key design variables with the addition of 65 mm/sec maximum speed, stroke length of 100–600 mm, and no back driving. This series is ideal for mobile off-highway applications (lifts on the back of vehicles, wheel chairs, etc.).

For more information:
Nook Industries, Inc.
4950 E. 49th Street
Cleveland, OH 44125-1016
Phone: (216) 271-7900 or
(800) 321-7800
www.nookindustries.com

Cabinet Inverters

PROVIDE COMPACT, FLEXIBLE CONTROL

Six sizes of the NORD SK 500E series control cabinet inverters are available, with outputs from 0.25 kW to 22 kW. Once the output range has been set, whether the basic model or a fully-equipped package of functions, the external dimensions of the unit are identical. Especially for conversions or extensions of functions, the uniform space requirements regardless of the options selected makes life easy for users.

Many common industrial applications can be implemented out of the box with these cost-effective units. All versions are equipped with brake management, brake chopper and mains filter, and they also provide sensorless current vector control, PID controller for process control as well as switchable parameter sets. Input and output options include two analog inputs and an analog output as well as two relay outputs, providing a wide range of connection options even with the basic model.

For more information:
Nord Gear Corp.
P.O. Box 367
800 Nord Drive
Waunakee, WI 53597
Phone: (608) 849-7300
Fax: (608) 849-7367
terry.schadeberg@nord.com
www.nord.com

Use of special lubricants can minimize friction and increase component efficiency by 10 percent (courtesy of Klüber).

A Need for Reduced Energy Costs

OPTIONS ABOUND FOR INCREASED EFFICIENCY IN LUBRICATION

Matthew Jaster, Associate Editor

When a bearing or gearbox fails in a wind turbine, the result is typically a domino effect. The component needs to be replaced, the new part needs to be manufactured and shipped and the turbine is out of commission until further notice. Operating costs rise, time is wasted and money lost in the process—typically thousands of dollars, considering the equipment involved. It's no wonder a component's efficiency is a priority in the manufacturing sector. Proper lubrication can reduce downtime, increase efficiency and improve the overall reliability of a system.

In manufacturing today, the push continues to cut energy

continued

costs, minimize friction and reduce CO_2 emissions. Highly specialized lubrication options are available for companies that work with gears, bearings and compressors in a host of power transmission applications. There are even monitoring systems specifically focused on lubrication to keep up with maintenance and reliability concerns. *PTE* magazine took a look at some of the different lubrication options available on the market.

Increasing Efficiency with Klüber Lubrication

Day after day, countless large and small cogs and wheels can be seen spinning in industrial installations worldwide. Innumerable gears, bearings and compressors work incessantly in assembly belts, baking lines, escalators, in cars and trains. This means not only a continuous flow of production, transport and assembly, but a constant consumption of energy as well. The reduction in energy consumption is therefore a major issue for the designers and operators of these installations, in particular because energy costs figure quite prominently among all the items on a company's bottom line. While energy is a major cost factor for its consumers, it should not be forgotten that its generation is also one of the main sources ofe greenhouse gas—CO_2—with its harmful effects on global climate. In North America, for example, the generation of one megawatt-hour of energy causes an emission of approximately 602 kilograms of CO_2 on average, depending on the regional energy mix of fossil fuels, nuclear power and renewable sources of energy. All over North America, approximately 5.1 million GWh of energy is generated each year, leading to a total emission of more than three billion tons of CO_2. Depending on the region, energy consumption by industrial users can be up to 20 percent.

SKF's WindLub helps extend turbine life and reduce operational and lubricant costs (courtesy of SKF).

Numerous national and international regulations and guidelines aim at reducing CO_2 emissions worldwide. In addition, a range of simple measures can be taken to efficiently reduce energy consumption. One such element is the use of specialty lubricants. In every set of gears and all bearings, friction is generated and thus valuable energy is lost. Measurements made on test rigs of Klüber Lubrication, München KG have shown that the use of suitable special lubricants can help to minimize friction and increase the component efficiency by up to 10%.

"In order to obtain maximum efficiency, tribologists look not only at the materials used for making the components, but also at the ambient conditions under which the component is intended to work in real life," explains Dennis A. Lauer, P.E., vice president engineering for Klüber North America. "Very high or very low temperatures may play a major role, as well as many other factors such as pressure, rotational speed or moisture. The selection of the right additives is decisive in any specific characteristics a lubricant will have."

An everyday example of this significant savings potential can be found in Munich's public transport system with its 761 escalators. These are driven via worm gears requiring an average driving power of 7.5 kW. With 4,000 operating hours per year, their total energy consumption is 30,000 kWh per unit. The use of specialty gear oil can help reduce energy consumption by some 10%. Consequently, the Munich public transport operator could cut costs by more than 200,000 euro each year and save the environment approximately 1,400 tons of CO_2 In a mega-city like Shanghai, with its 2,600 escalators in the public transport sector alone, savings of huge proportions are feasible.

The potential for savings becomes even more apparent in another example: a large airport may utilize more than 20,000 gear units, for example, in conveyor belts and escalators. Approximately 15,000 of them may be spur and bevel gears with a mean power of 5 kW and another 5,000 worm gears with a mean power of 15 kW. With some 4,000 operating hours a year and a utilization rate of 40%, total power consumption is at approximately 240 GWh. Replacing a mineral oil with a polyglycol specialty oil will increase the efficiency of all gears by roughly 5.25%, on average. The power saved is 12.6 GWh—or the annual power consumption of approximately 3,000 private households. Put another way, 12.6 GWh (12,600 MWh) translates to, on a North American average, the emission of more than 7,500 tons of CO_2. Based on an energy price of 7 cents-per-kWh in North America, more than 880,000 U.S. dollars can be saved in this way.

"These calculations clearly show how lower energy consumption can benefit the environment and at the same time reduce operating costs in the long term," explains Lauer. "When looking at the whole picture, and when considering the cost benefit aspect, a seemingly higher-cost, high-performance lubricant can in fact be more economical. After all, less friction means less wear, longer maintenance intervals, lower energy consumption and hence less strain on valuable resources."

Following extensive R&D work and a comprehensive performance test program, Klüber Lubrication has developed three synthetic high-performance, high-load gear oil products including Klübersynth GEM 4 N (polyalphaolefin), Klübersynth GH 6 (polyglycol) and Klübersynth GEM 2 (rapidly

A large airport may utilize more than 20,000 gear units in conveyor belts and escalators (courtesy of Klüber).

biodegradable ester). These gear oils meet the demanding requirements for gear performance, offering wear protection and resistance to micropitting, foam and residue formation. Compared with other standard gear oils, these products show good aging resistance, high load-carrying capacity and low friction values. Consequently, oil change intervals are increased, power loss is reduced and the resulting yield increases over the operative life of a wind turbine, for example.

Shell Meets Challenging Operating Conditions

To meet the growing demand for wind energy in North America, Shell Lubricants is making available a new portfolio of products that meets the toughest applications, specifically in hydraulic systems, blades, gearboxes, yaw and pitch drives. Shell Lubricants provides products and services for the entire wind value chain—e.g., component manufacture, turbine assembly, transportation, construction, installation and service. The company recognizes the impact of reduced reliability and the demands of operating wind farms in remote locations (both on- and off-shore) and in challenging climatic conditions. As a result, high-quality lubricants and greases suitable for providing long service life and equipment protection are required. In order to keep a wind turbine running reliably and to extend component life, Shell supplies a wide range of products.

"Our laboratories in Asia, Europe and North America provide the Shell Lubricants team the ability to develop cutting-edge technology for wind energy customers," says Felix Guerzoni, product application specialist. "Our strong belief in 'world-class technology working for you' helps us to develop our most technically advanced products and services for our customers. Our lubricants are rigorously tested in our labs, with equipment manufacturers and in real turbines during the development process so that our products meet the demands of our customers' operations throughout North America."

Shell Lubricants works closely with leading wind turbine manufacturers, component suppliers and industry associations to understand emerging lubrication needs and rapidly changing industry and manufacturer specifications. Shell Lubricants complements its products with a comprehensive oil analysis program, Shell LubeAnalyst, which can be used to help operators monitor the condition of their lubricant and equipment and avoid unscheduled downtime.

Some of the leading products Shell Lubricants offers to meet the demands of wind turbines include Shell Tellus Arctic 32, a hydraulic fluid used for extreme-climate wind turbines and recommended or listed by leading suppliers such as Svendborg Brakes, and by wind turbine OEMs including GE Wind, Voith Wind, Vestas, Dongfang Wind Turbines, Sinovel, RePower, Nordex and DHI. The product has demonstrated its performance in the harsh winters of Mongolia, Scandinavia and the Americas at temperatures as low as –40 degrees C.

The massive blades of a wind turbine are adjusted using grease-lubricated blade bearings, which if insufficiently lubricated can fail through fretting and false-brinelling. Shell Rhodina BBZ is designed to provide protection to bearings

continued

against fretting corrosion, moisture contamination and false brinelling at temperatures as low as –55 degrees C. Shell Rhodina BBZ lubricates the blade bearings of many wind turbines globally with leading blade bearing suppliers such as Rollix, Rothe Erde, IMO, Rotek, Liebherr and wind turbine OEMs including Vestas, Acciona, Gamesa, Dongfang Wind Turbines, Sinovel and Siemens.

Gearbox reliability is also critical for wind turbines. Shell Omala HD 320 synthetic gear oil provides protection against common failure modes, including micropitting and bearing wear. Offering low-temperature fluidity and long oil life, Shell Omala HD 320 provides benefits for difficult-to-maintain wind turbine gearboxes. Additionally, Shell Lubricants offers Shell Tivela S 150 & 320 synthetic gear oil for yaw and pitch drives; Shell Albida EMS 2 electric motor bearing synthetic grease; Shell Stamina HDS main bearing grease; and Shell Malleus GL & OGH premium quality open gear grease.

SKF Offers Wind/Lubrication System

With the SKF WindCon system, operators can take a proactive approach to maintenance. The system allows the operator to monitor a turbine or an entire wind farm and predict when maintenance will be necessary. WindCon collects and analyzes the mechanical data, compiles it, and provides a reliable performance overview in order to extend time between site visits, predict failures before they occur and plan maintenance activities more effectively. SKF WindCon is easy to use and requires no special training or software. Data is presented using an Internet browser, and the information is up-to-the-minute. The web-based version of SKF WindCon takes advantage of WebCon—SKF's data warehousing and web hosting services. WebCon helps to shorten lead-time from alarm to solution, since authorized personnel can do monitoring from any location with a computer or hand-held device with Internet access.

SKF's WindCon provides a performance overview and plans turbine maintenance for operators (courtesy of SKF).

The simplified maintenance and increased reliability that SKF WindCon provides can be enhanced with WindLub—SKF's centralized automatic lubrication system for wind turbines. WindLub easily integrates with SKF WindCon; so along with fully automated lubrication, the combination provides operators with a complete overview of the lubrication system, including pump status and grease levels.

"Ensuring constant and well controlled lubrication is a challenge," says Victoria Wikstrom, marketing manager general industry. "This is usually done through a central lubrication system that pumps grease or oil to the locations where it is needed."

While SKF WindCon is user-friendly enough to be operated by wind farm technicians, many users choose to have SKF monitor and manage the system for them. A team of SKF engineers does so from The SKF Intelligence Centre Wind - a facility in Hamburg, Germany dedicated solely to wind turbine condition monitoring issues and the management of installed systems. To simplify maintenance and reduce environmental impact, SKF WindLub centralized lubrication system delivers the exact quantity of the appropriate lubricant at the right positions at the right time to all rotating equipment. SKF WindLub helps to increase turbine reliability and availability and helps to extend the turbine's service life and reduce operational and lubricants costs. Additionally, SKF WindLub minimizes environmental impact by avoiding over-greasing.

The combination of WindLub and WindCon provides operators with a complete overview of the lubrication system. "Our ability to increase service life with greater precision will increase thanks to an improved understanding and computer modeling of lubricant behavior," Wikstrom adds.

The advantages of an investment in a central lubrication system include the high-pressure technology that makes it suitable for rotary operation; greases with high solids content can be fed easily; it's available as a pre-assembled kit, which means low mounting effort and reduced mounting errors; individual supply of lubrication points; electronic fill level control; visual stroke monitoring of the lubrication cycle; and the system components are available in corrosion-resistant designs for off-shore applications.

Timken Adds Power Transmission Systems and Services

Leveraging organic investments sustained during the recession to expand both its wind power offering and capacity domestically and internationally, The Timken Company introduced a number of new product developments this year. Timken recently retooled and expanded facilities in Asheboro, NC and Tyger River, SC, to serve its customers, in addition to existing wind bearing production in Wuxi, China; Chennai, India; and Ploiesti, Romania. In May, the company began shipping its initial production from a new plant in Xiangtan, China. Timken also provides clean steel from its facilities in Canton, Ohio for its own production and various wind energy components for other customers. Now working with the world's leading wind turbine manufacturers at varying stages of development, Timken has established a supply chain dedicated to serve the wind industry.

"From engineering investment to our manufacturing and service capabilities in every part of the world, Timken is in the best position to deliver exceptional value and life cycle

support to customers who are developing the next-generation, multi-megawatt-class turbines," says Christopher Coughlin, president of Timken's Process Industries Segment.

One recent development is a wind energy lubrication system, offered in high pressure and low pressure variants, providing a versatile pumping method. The lubrication systems provide 'cold climate' pumping properties, reduced side loading and maximum bearing life by ensuring precise amounts of lubrication are delivered to each bearing row.

Timken's LP system is a low-pressure centralized lubrication system that directs grease inlets and uses an active purging method to reliably lubricate bearings. With this system, a central pump automatically delivers lubricant through a supply line to multiple banks of injectors. When used with tapered roller bearings, each injector bank operates independently to lubricate each bearing row at the small end of the roller.

The economical high pressure system provides automatic lubricant delivery through a single divider block, which displaces a fixed amount of lubricant to each lube point on the bearing assembly. A moving indicator pin attached to the divider block allows for easy monitoring through a proximity switch. Injected grease creates pressure in the system to force out old grease into disposable waste containers.

Other new developments from Timken for the wind energy industry include wear-resistant cylindrical or spherical bearings, tapered roller bearings, three new wind energy seals, an online intelligence system for condition monitoring and Syber, an advanced wind system analysis program.

Turbine Efficiency with Dow

A more efficient wind turbine that will generate even more wind-driven electricity is now possible with the recent introduction of the Dow UCON GL-320 lubricant. Dow introduced the new product during the 2010 STLE Annual Meeting in Las Vegas. Dow UCON GL-320 lubricant was developed to better lubricate the gearboxes of wind turbines, though the same lubricant can be used effectively for other types of gearboxes. The company believes organizations may produce and sell more power with this lubricant for three reasons: First, in cold weather, turbines can shut down due to filter failures caused by high lubricant viscosity. The higher inherent viscosity index of UCON GL-320 lubricant addresses this issue without the need for additional viscosity index improvers. Second, when turbine output is at the maximum, high gear oil temperatures can lead to shutdowns. UCON GL-320 lubricant has a higher heat capacity than hydrocarbon oils, which allows it to move more heat, reducing these shutdowns. Lastly, UCON GL-320 lubricant has better lubricity at ambient conditions, meaning that it has the potential to shift the power versus wind speed curve to the left, leading to greater power output when the production is less than the maximum design output.

Dow UCON GL-320 lubricant is a new polyalkylene glycol (PAG)-based lubricant developed based on Dow's experience in manufacturing PAG-based products. The combination of the PAG base along with a proprietary Dow additive package yields a ready-to-use product with specific performance properties required for the successful operation of wind turbine and other gearbox operations.

The main components of the wind turbine are the huge blades that turn in the wind. But there is much more to this sustainable power source than these. The gearbox and the generator to which it is attached are both key mechanical and power generating elements of a wind turbine. Keeping gears and moving parts well lubricated is important to overall system efficiency and longer equipment life, according to Dow. Gears and bearings can be permanently damaged after only a few minutes of improper lubrication. Less expense for maintenance and a better overall operation are benefits this new lubricant will deliver to wind turbine owners and operators.

"Imagine the expense of working on a wind turbine that is located out in the Gulf of Mexico," says Brian Goldstein, marketing manager for Dow UCON. "If using better lubricants extends equipment life and maintenance intervals, therefore reducing costs associated with rental of crew boats and offshore cranes, plus the people with the special skills needed for this type of work, then we believe that Dow UCON GL-320 is an excellent value."

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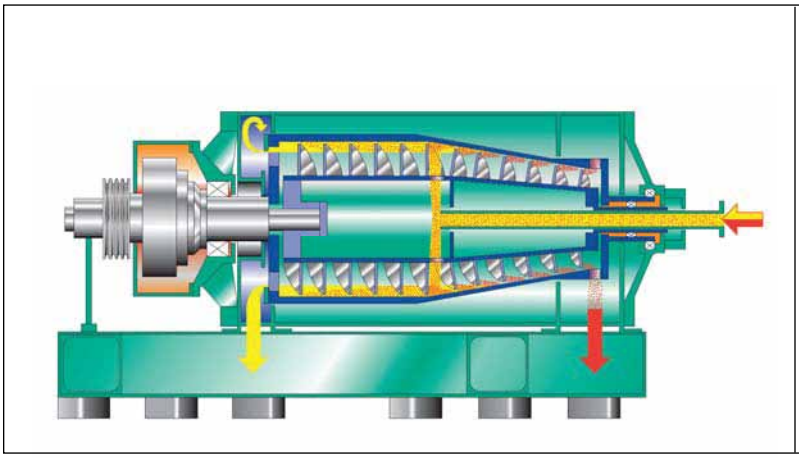


Figure 1—Decanter (closed-bowl) centrifuge.

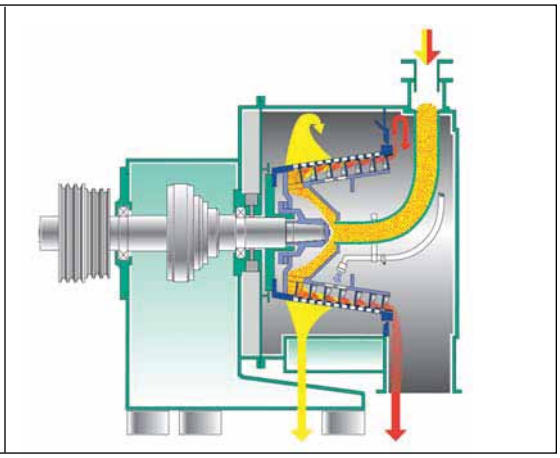


Figure 2—Screen (open-bowl) centrifuge.

Gear Drives

USED IN CENTRIFUGE APPLICATIONS

STEFANIE BURNS AND CHRIS MAYR, SUMITOMO DRIVE TECHNOLOGIES

Sumitomo Drive Technologies may not have the centrifuges that Kevin Costner is promoting in the Gulf Oil Spill (*Ed.'s note: The film actor's company, Ocean Therapy Solutions, has developed a device—the V20 Centrifuge—that purportedly can separate oil from water to a purity level of 99.9 percent.*) However, we do provide centrifuge drives that will do just that. How do these drives work? It can be as simple or complex as you like it to be. Centrifuges use a cylindrical motion to force the solids away from the liquid. This concept is being used in the Gulf BP oil spill to separate oil from seawater.

The marketing information provided about these applications is very limited, and the user generally does not have an in-depth understanding, even among engineers, and therefore take information as presented at face value. In order to make better purchasing decisions about centrifuge applications, one must understand the concept of centrifuges and the drives that operate this equipment.

Sumitomo is only one of many that make a gear drive suitable for centrifuges. We offer two different designs of centrifuge gear drives that will break away solids from liquids, i.e.—a decanter (closed-bowl design) and a screen centrifuge (open-basket design). The design preference is dependent on the OEM's equipment design. But for either type, you will need a gear drive to operate the conveyor within the centrifuge.

Decanter centrifuge (Fig. 1). Decanters are closed-bowl type applications providing a housing and bowl that operate at different speeds.

A decanter needs a bowl with a completely closed drum. Inside this bowl is a worm conveyor, with both the drum and the conveyor driven by a gearbox. The bowl is connected to the gearbox housing and the conveyor is connected to the output shaft of the gearbox. It is called a decanter because the liquid pours out as if from a wine decanter; and in the other side there is a solid discharge (similar to wine sediments) that is transferred to the smaller end of the bowl with a conveyor. Inside, the product under process is mixed with liquid and solids, e.g., saltwater, muddy water or oil and water (it just has to be mixed weights).

The liquid runs via centrifugal force at high rotational speed of the bowl towards the larger diameter, and the solids are pushed to the smaller diameter of the bowl. In this tapered area, the solids slowly come out of the liquid and are dried before being disposed. The gearbox is creating differential or relative speed between the conveyor and the bowl. Through this relative speed, the solid transportation works and we are able to separate the liquid from the solid. The gearbox rotates together with the bowl and is driven by a belt drive from the main motor. The bowl operates at the same speed as the gearbox housing, while the input shaft connected to the conveyor is operating at a different speed, creating centrifugal force.

Screen centrifuge (Fig. 2). Screen centrifuges have an open bowl, or what

we call a screen basket. The bowl itself has holes. The basic function is the same—the screen basket (or bowl) is fixed to the gearbox housing and the conveyor belt drive is fixed to the output shaft—both operating at different speeds to create the centrifugal force.

The bottom line: What is centrifugal force? Quoting Schwarz, "This is the most obvious parameter to use when considering the actions of a centrifuge. The maximum centrifugal acceleration developed inside a centrifuge is a function of its radius and angular rotational speed. More commonly, the term G-Force (G-Value) is used instead of acceleration. The G-Force is defined as the multiple of the gravitational constant that is obtained in the centrifuge. The centrifugal acceleration (G-Force) will increase with the bowl diameter and the bowl speed." (Ref.1).

Some manufacturers differentiate themselves by offering smaller-diameter machines, claiming they will achieve the same flow rates as larger-size diameters. While the flow rates may be achievable, it is highly unlikely that the same separation performance will result. The diameter is key when looking for the capacity of conveying solids to provide greater suspension volume for settling out solids. (Ref.1).

Purpose of a gearbox in a centrifuge application.

Typical
Application:

$T_{conveyor}$ = 5,000 Nm
$n_{conveyor}$ = 2,525 rpm
n_{bowl} = 2,500 rpm

1. Centrifuge without gearbox:
   $P_{conveyor}$ = 5,000 x 2,525 / 9,550
   = 1322 kW

2. Centrifuge with gearbox:
   Relative speed = $n_{conveyor} - n_{bowl}$
   = 2,525 – 2,500
   = 25 rpm
   $P_{conveyor}$ = 5,000 x 25 / 9,550
   = 13.09 kW

The centrifuge gearbox allows running the centrifuge with the practicable power requirement. The main power portion is the energy in the rotating mass of the bowl and the conveyor.

Selection of gearbox. Now that you realize you need a gearbox, you must first obtain from OEMs the following information in order to select the proper one:

1. Torque (T_2)
   - This is the torque needed for the conveyor.
2. Rotational Speed (n_3)
   - Rotational speed of the bowl.
3. Relative Speed ($n_2 - n_3$)
   - Speed between the conveyor and the bowl.
4. Is the conveyor faster or slower than the bowl?
   - A gearbox can do either. This is usually a design preference from the OEM (centrifuge manufacturer).
5. Lubrication System
   - Grease Lubricated
   - Oil Bath Lubricated
     * Closed System without Oil Reservoir
     * Open System with Oil Reservoir
   - Oil Circular
   - Oil Once-Through
6. Draft Design
   - A draft design is usually provided from the OEM in order for the gearbox manufacturer to suggest a proper size and type.

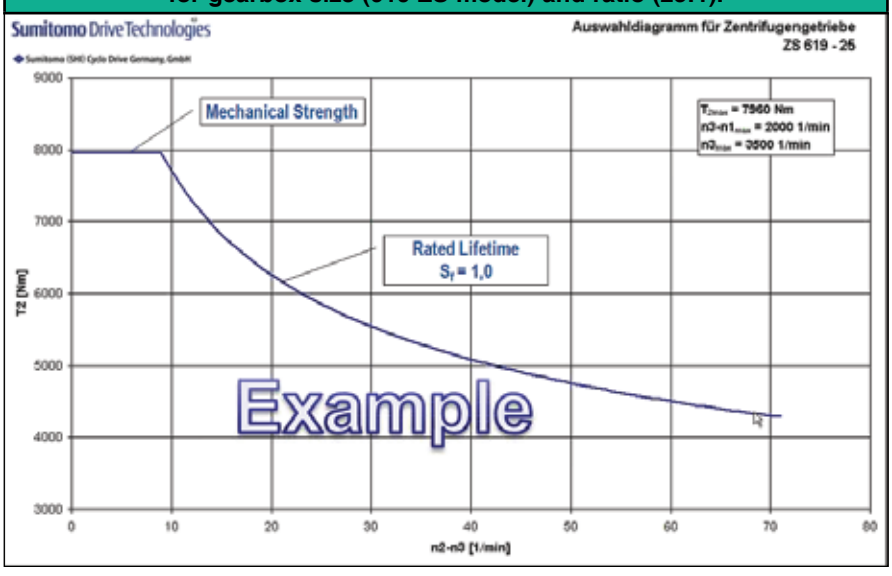
Following is the required information to calculate the proper gearbox:

- n_1 = rotational speed of high speed shaft
- n_2 = rotational speed of slow-speed shaft and conveyor
- n_3 = rotational speed of gearbox housing and bowl
- n_2–n_3 = relative speed between slow-speed shaft with conveyor and gearbox housing with bowl
- n_3–n_1 = relative speed between gearbox housing and high-speed shaft
- $(n_3–n_1)/(n_2–n_3)$ = relation between relative speeds (= ratio i of the gearbox)
- $–i$ = slow-speed shaft and con veyor are faster than bowl
- $+i$ = slow-speed shaft and conveyor are slower than bowl
- T_2 = torque at slow-speed shaft and conveyor

Example—Table 1. Here is a selection diagram that shows the available torque over the differential speed for a certain gearbox size (619 ZS model) and ratio (25:1). It shows the maximum torque (8,000Nm) and maximum-input, relative speed (2,000 rpm), as well as the maximum bowl speed (3,500 rpm). If we divide the maximum-input relative speed by the ratio (2,000/25), we are then able to produce up to a 70-rpm differential speed on the output side. This diagram is limited by the mechanical strength at the maximum torque and by the rated life of the eccentric bearing (in this case, service

continued

Table 1—Selection diagram—available torque over the differential speed for gearbox size (619 ZS model) and ratio (25:1).



factor = 1.0) in that it has a B10 life of 8,000 hours. If we continuously run the machine at 40 rpm and a little over 5,000 Nm, then we have a rated life of approximately 8,000 hours. This is the philosophy behind selecting the correct product.

Sumitomo's centrifuge drives—Table 2. Sumitomo offers a variety of gearboxes that are used in both decanter and screen centrifuges. The balanced housing is connected with the bowl and turns at the bowl speed. The output shaft of the centrifuge reducer is connected to the conveyor and transmits the torque that is needed for the solids transport. The input shaft can be locked by a torque arm or driven by a backdrive motor to provide the necessary relative speed.

The flexible lubrication system allows grease lubrication as well as oil lubrication—depending on a user's requirements. Mounting dimensions can be designed to fit into all applications.

Sumitomo offers four different main types of drives available that meet users' specifications for centrifuges:

ZS is a single-stage cyclo drive centrifuge reducer for most applications when the conveyor turns faster than the bowl.

The ZSPN and ZSPV are both double-stage centrifuge drives with a cyclo drive stage and a planetary stage for higher ratios. ZSPN provides the conveyor slower than the bowl (positive ratio); ZSPV provides the conveyor faster than the bowl (negative ratio).

The ZSPR is a very special double-stage centrifuge drive with a cyclo drive stage and a differential planetary stage. This version allows variable relative speed over the full control range of the motor with either a slower or faster conveyor.

Also available is the purely planetary ZSP as a double- or triple-stage design. This type is mainly used for applications with high bowl speed and high differential speed.

What is a "cyclo" drive stage? Sumitomo's cyclo drives are cycloidal reducers intended for gear drive applications. The cyclo's epicycloidal design has advantages superior to speed reducers using common involute tooth gears, in that cyclo components operate in compression, not in shear. Unlike gear teeth with limited contact points, a cyclo has two-thirds of its reduction components in contact at all times. This design enables cyclo speed reducers and gear motors to withstand shock loads exceeding 500% of their ratings while providing exceptional performance, reliability and long life in the most severe applications (Fig. 4 and Table 3).

Table 2—Sumitomo drives for users' specifications for centrifuges.

Type	Cyclo	Planetary	Stage	Shaft	Ratio	Rotating Direction Input/Output
ZS	X		1	3	-	Opposite
ZSPV	X	X	2	3	-	Opposite
ZSPN	X	X	2	3	+	Same
ZSPR	X	X	2	4	+/-	Same/ Opposite
ZSP		X	2 or 3	3	+/-	Same/ Opposite

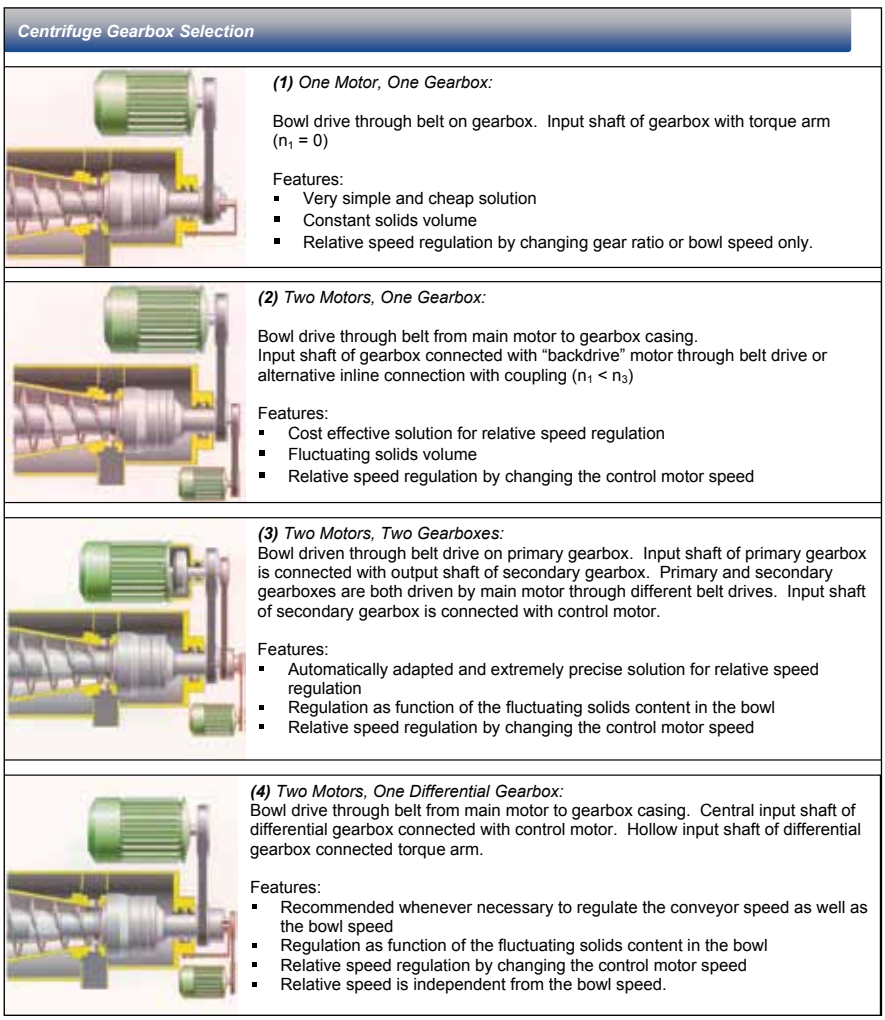


Figure 3—Centrifuge gearbox selection.

Conclusion

Centrifuges have been used in oil fields since the early 1950s. More recently, their role in the oil field has expanded to include environmental cleanup. Unfortunately, processing through a centrifuge alone will not solve the disaster in the Gulf. This is only a small portion of the oil separation process and will require further treatment.

BP has already purchased over 30 centrifuge drives to clean up the oil spill in the Gulf. (Officials) say skimmer ves-

sels will pump oily water onto a barge where the centrifuges can process a total of 600,000 gallons a day, separating the gunk from the water.

Centrifuges are a technology that will continue to improve, develop and be used in all types of applications that require separation of liquid from solids.

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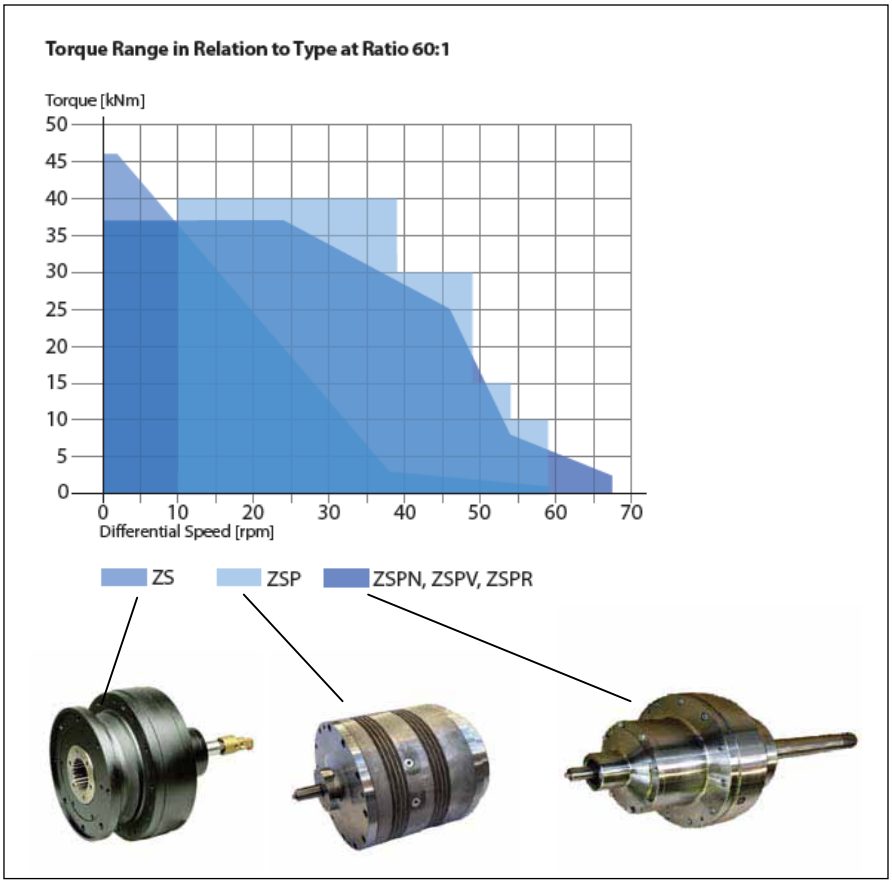

Figure 4—Torque range in relation to type at ratio 60:1.

Table 3—Selection of gearbox type.

	ZS	ZSPV	ZSPN	ZXPR	ZSP
Torque Range	3	2	2	2	1
Shock Overload	3	2	2	2	1
Lubrication	3	2	2	2	2
Bowl Speed	2	2	2	2	3
Relative Speed	1	2	2	2	3
Speed Variation	1	2	2	3	2
Diameter	1	1	1	1	3
Weight	2	1	1	1	3
Cost	3	2	2	1	1
	19	16	16	16	19

**** 1 = Good, 2 = Better, 3 = Best***
***** Sumitomo is the only centrifuge gearbox manufacturer who supplies a complete range of ALL possible types of centrifuge gearboxes.***

Sensing the Motion:

Figure 1—Examples of "macro" motion control applications.

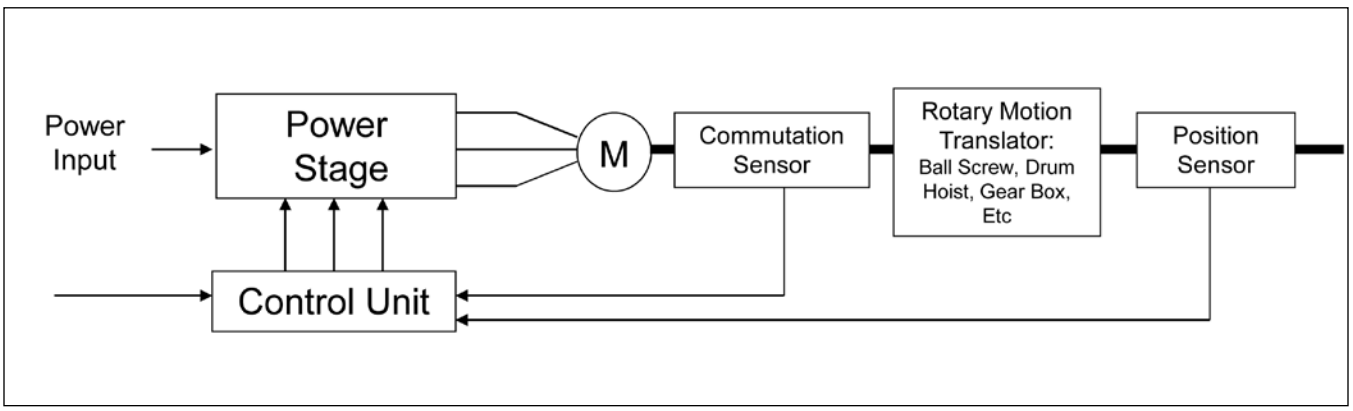

Figure 2—Block diagram of typical actuation system.

Rotary Position Sensors—

ELECTROMECHANICAL, ELECTRONIC AND FIBER OPTIC

Dennis Horwitz, Micronor, Inc.

Management Summary

Motion control requires feedback. Without feedback, there is no controlled motion. Position sensors are a key element of a motion control system, regardless of whether the primary power is hydraulic, pneumatic or electrical. There are a multitude of position feedback sensor options that reflect a very broad range of technologies—from electromechanical to electronic to optoelectronic to state-of-the-art fiber optics. Design decisions are usually based on a multitude of factors—including environmental, reliability, redundancy, safety and reliability. These applications can also reflect a preponderance of conservatism versus state-of-the-art in a spirited clash of the old school versus new school of engineering.

This paper provides an overview of the more common position sensor options and references actual case studies to illustrate the diverse solutions available and the reasons behind some of the decisions. Three cases are used to illustrate the needs of different applications leading to the choice of a particular type of position sensor. The cases reviewed include a gantry crane, wind turbine and aerial cable car.

Introduction

The world of "macro" (a.k.a. large-scale) power transmission and motion control offers special engineering design challenges because of the sheer size and loads of the mechanisms and structures. The following list of examples characterizes the diverse range of applications and operating environment extremes that can be encountered:

- Cranes
- Aerial cable cars
- Retractable stadium roof
- Leaf, lift and rotary bridges
- Oil drilling rigs
- Tank turrets
- Satellite antenna positioning systems
- Aircraft flight actuators
- Wind turbines
- Ship propulsion systems
- Space station solar panels

Figure 2 illustrates a typical closed-loop motion control system. A typical system consists of these features:

- Motor or actuators can be electric, hydraulic or pneumatic.
- Commutation control of an electric motor can be accomplished via position sensor or sensorless V/I feedback. Sensor-based feedback tends to provide more precise control.
- Actuation usually requires converting rotary motion of a motor to the linear or angular motion required of the structure. For example, a crane's hoist lifts or lowers a cargo container while a wind turbine must be rotated to accurately face the wind.
- External position sensor allows direct monitoring of the position/speed independent of the feedback sensor used for directly controlling the motor. However, some applications can use one sensor for both controlling the motor as well as monitoring the position of the structure.

The options available for position/speed sensors cover a wide range of technologies, performance and technical maturity. Electromechanical solu-

continued

tions (requiring no external electronics) include discrete limit switches and geared cam switches. Electrical and electronic solutions include resolvers, magnetic Hall sensors, optical proximity sensors and digital encoders. State-of-the-art fiber optic encoders offer the advantages of passive operation (no local power supply required), EMI immunity (like limit switches), superior environmental performance (like resolvers) and ability to operate over extremely long distances (the reason why telecommunication networks use fiber optics for long-distance communications). Systems may also implement a hybrid, integrated solution; for example—combining encoders for advanced motor drive speed control along with electromechanical limit switches for fail-safe backup alarms. In any case, the decision making process should consider total life-cycle costs (including purchase price, operating costs, reliability and potential repair/replacement costs) as well as the customer's technical "comfort zone."

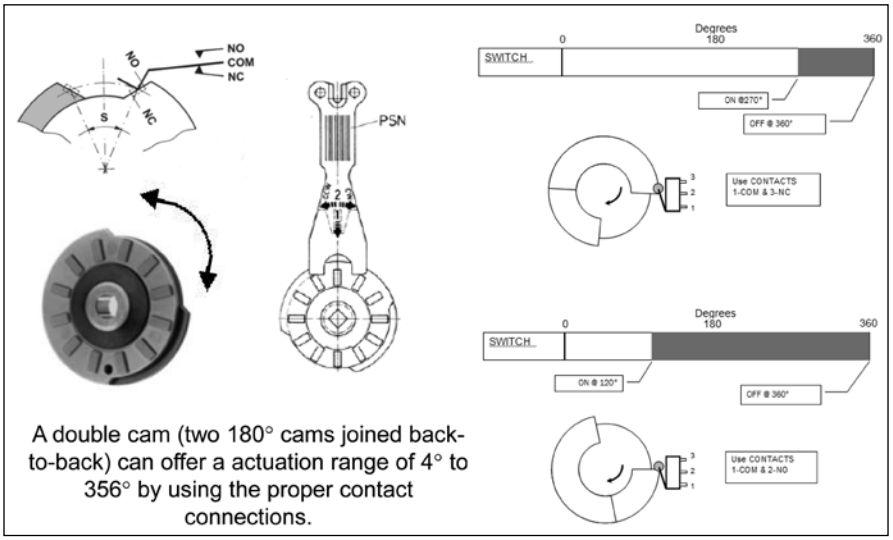

Figure 3—How a rotary cam switch works.

Figure 4—Gantry crane motion and inside view of geared limit switch.

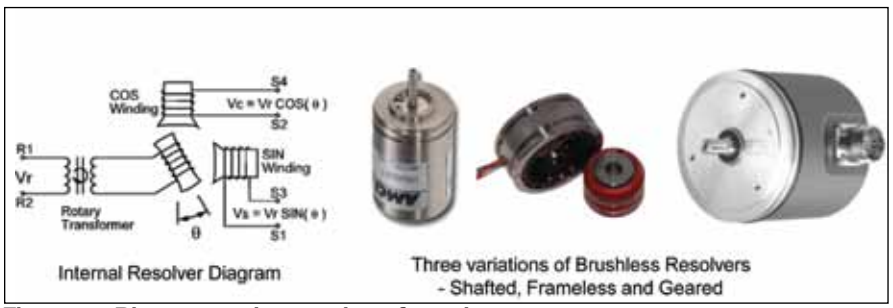

Figure 5—Diagram and examples of resolvers.

We will use three real-world applications to introduce the different types of position sensors and put some of the decision making issues into context: a cargo crane, wind turbine and aerial cable car. Then we will summarize the various sensor technologies and compare their advantages and disadvantages.

Case #1—gantry crane and geared limit switches. Cranes and hoists are traditional users of rotary limit switches. Cam switches are the most basic and direct form of discrete position feedback or fail-safe backup control. No electronics to power. No computer to program. No software to maintain. Unaffected by EMI or lightning. Simple, rugged, robust and reliable. As shown in Figure 3, cams are mechanically programmed to physically activate/deactivate one or more microswitches corresponding to specific payout positions of a cable wound around a motor-driven drum. Typical applications include chain- or cable-driven drum hoist mechanisms used on lift bridges, dam gates, cranes and hoists.

The gantry crane shown incorporates two degrees of motion: the up-and-down motion of the hoist and the linear movement from ship to truck trailer along the gantry rail. For this example, let's just consider the critical upper- and lower-end limits of the hoist. The hoist position is controlled by a heavy-duty steel rope that pays out from a rotating drum. The rotary limit switch is direct-coupled to the drum shaft with an internal gear reduction corresponding to the number of drum revolutions corresponding to full payout of the cable. Let's assume that 100 turns of the drum corresponds to 100 feet of hoist travel (one turn of the drum corresponds to 1 foot of hoist movement). Thus, the selected gear reduction of the limit switch is 100:1, so that 100 turns of the input shaft corresponds to one full turn of the cam.

Keep in mind for safety reasons that the hoist should never hit the ground

or rise above a certain limit that would overrun the top of the hoist. For a lower limit of 4 feet (about one-half container height), we would set the lower-limit cam switch to activate at 4 turns—also corresponding to the 150 (4/100 x 3,600) cam position. For an upper limit of 80 feet, the upper-limit cam switch would be set to activate at 80 turns or 2,880 cam position (80/100 x 3,600).

Case #2—wind turbine and combination yaw/cable twist sensor. The wind turbine yaw mechanism is used to turn the wind turbine rotor against the wind. To generate power efficiently, it is critical that the wind turbine be positioned perpendicular to the wind. Remote wind sensors feed the yaw motor controller with real-time information while the yaw sensor provides real-time feedback of its position. Continuous-position feedback could be supplied by either a resolver or encoder.

Which should be selected?

A *resolver* is a rotary transformer where the magnitude of the energy through the resolver windings varies sinusoidally, as the shaft rotates. As shown in Figure 5, a resolver control transmitter has one primary winding—the reference winding; and two secondary windings—the SIN and COS windings. The SIN and COS windings are mechanically displaced 90 degrees from each other. In a brushless resolver, energy is supplied to the reference winding (rotor) through a rotary transformer. A resolver requires an external R/D (resolver-to-digital) interface.

An *optical rotary encoder* is an optoelectronic device used to convert the angular position of a shaft or axle to an analog or digital code. The optical encoder's disc is made of glass with transparent and opaque areas. As shown in Figure 6, a light source and photo detector array read the optical pattern that results from the disc's position at any one time. This code is read by an embedded processor to process encoder signals and a digital output. There are two types of optical rotary encoders: incremental and absolute.

An *incremental rotary encoder*—also known as a quadrature encoder or a relative rotary encoder—has two outputs, i.e., quadrature outputs. These A and B quadrature outputs are 90 degrees apart. The resolution of an incremental encoder is expressed in pulses-per-revolution (PPR) and can range from 100 PPR to as high as 100,000 PPR in some high-resolution models. Optionally, there can be an index (Z) output that provides a reference position corresponding to one PPR. The motor drive or actuator system can count pulses (from an initial reference point) to determine position and measure the time between pulses to determine shaft speed (RPM).

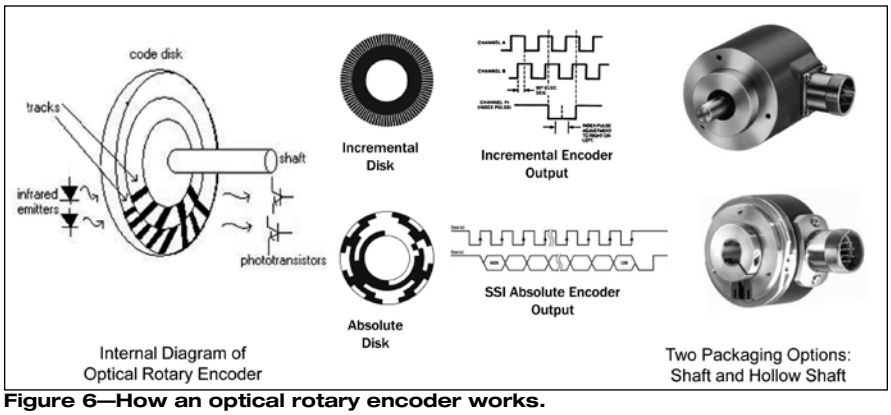

Figure 6—How an optical rotary encoder works.

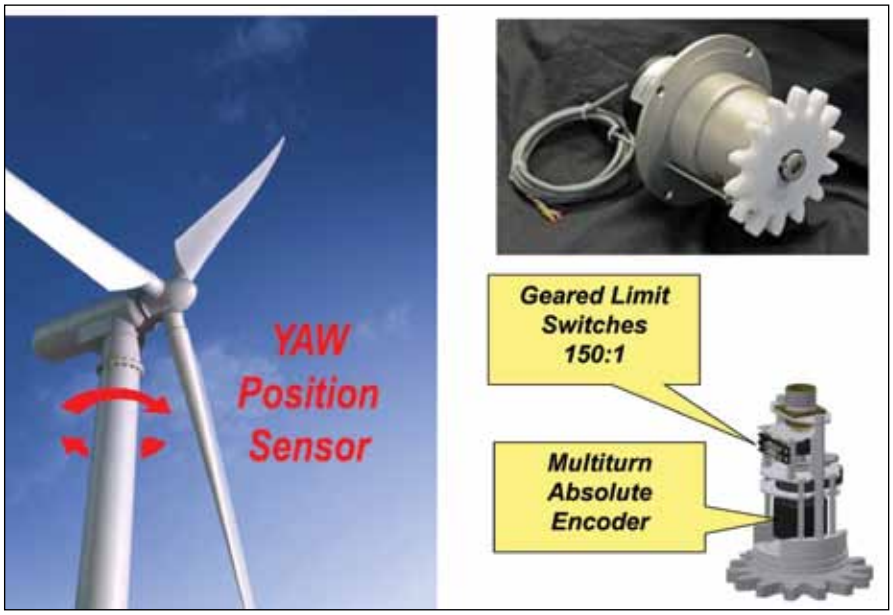

Figure 7—Multifunctional yaw position sensor for wind turbine application.

An *absolute rotary encoder* incorporates a glass code disc that contains a binary or gray code scheme that provides a unique output for any position. An embedded processor reads this code and provides either an analog or digital output. The digital output can be parallel, *RS485* serial, *SSI*, *Profibus*, *CANopen* or other type of field bus interface. Analog output can be either 0–10V or 4–20mA. Since absolute encoders are not ideal for speed control, special models also offer an A/B incremental track option.

A particular wind turbine design required two yaw sensor functions—yaw angular position *and* cable twist alarms. The latter prevents the internal power cables from over-twisting and potential damage. When the turbine reaches either of the CW or CCW cable twist limits, the system must then brake to prevent further rotation and also trigger the yaw motor drive to return the system to its center position.

These dual requirements could have been accomplished using two separate devices— an encoder and a geared limit switch (such as from the previous example)—but this requires significant mechanical design and additional parts. As shown in Figure 7, a multifunctional position transducer solution was chosen—integrating both an encoder (angular position) and dual-channel geared limit switches (CW and CCW

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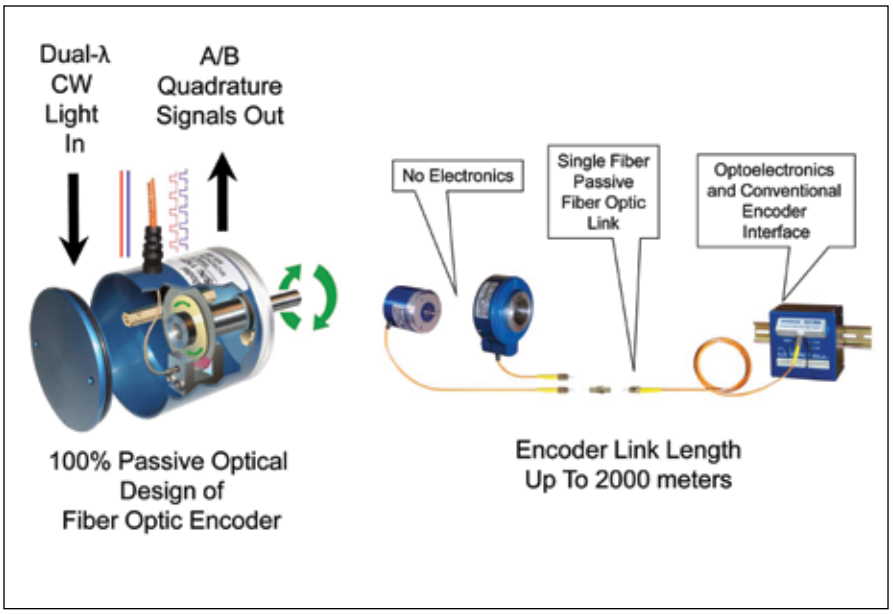

Figure 8—How a fiber optic rotary encoder works.

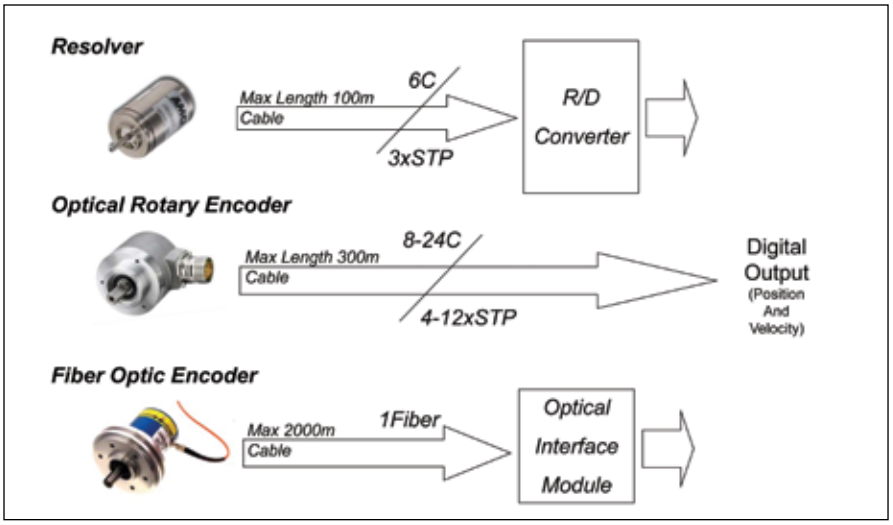

Figure 9—Comparison of resolver and encoder interface configurations and distance limitations.

Figure 10—Portland aerial tram uses fiber optic rotary encoders.

cable twist alarm set-points). This integrated unit mounts and couples directly to the main bull gear, simplifying mechanical design, minimizing parts, maximizing reliability and offering ease-of-installation and/or replacement.

Case #3—fiber optic rotary encoder for aerial cable car. Unlike the conventional optical rotary encoder, the *fiber optic rotary encoder* incorporates a unique, all-optical, totally passive design. As shown in Figure 8, the encoder uses a patented, wavelength division multiplexing technique that, essentially, shifts the optical rotary encoder's optoelectronics to a remote optoelectronics interface module and with all transmission occurring over a single fiber. In the fiber optic incremental encoder, two wavelengths are used, each corresponding to either the A or B quadrature signal.

The fiber optic rotary encoder is a deceptively simple design, consisting mainly of just two key components: a code wheel and the optical head. The fiber optic encoder's minimalist design makes it more robust and reliable than the complex, multi-component design of the mainstream optical or magnetic rotary encoder. The totally passive sensor offers EMI immunity, resistance to lightning, ground isolation and the ability to operate over extremely long distances (up to 2,000 m)—unmatched by any other type of position sensor. As drop-in substitutes for conventional encoders, the fiber optic encoder is also offered in both incremental and absolute models, as well as shafted and hollow-shaft configurations.

Aerial cable cars face conditions for which conventional optical rotary/magnetic encoders or resolvers were not suitable, due to exposure to lightning, EMI issues around large variable frequency drives (VFD), difficulty of providing power on high towers and the long-distance runs to remote sites and towers. A comparison of interface, distance and cabling characteristics of optical encoders, resolvers and fiber optic encoder is shown in Figure 9. In the case of the aerial cable cars, the fiber optic encoder best addresses the requirements and, in addition, offers the simplest installation solution (i.e., no remote power required or complex multi-conductor cable runs).

Table 1—Summary of the advantages and disadvantages of the five major types of position feedback sensors discussed in this paper.

Type	Geared Limit Switch	Resolver	Optical Rotary Encoder	Magnetic Rotary Encoder	Fiber Optic Rotary Encoder
Classification	Electronmechanical	Electrical (requires remote R/D interface)	Optoelectronic	Megnetic/Electronic	All Optical
Years in Use	100+ years	50+ years	10+ years	5+ years	5 years
Multiple Suppliers?	Few	Few	Few	Few	Few
Active or Passive Sensors?	Passive	Semi-Active	Active	Active	Passive
Temperature Range	-40/+85 C	-55/+125 C	-20/+70 C (+100C)	-20/+70 C (+100C)	-60/+150 C(+150 C)
External Interface Required?	No	Yes	No	No	No
Discrete or Continuous Position?	Discrete	Continuous	Continuous	Continuous	Continuos
Sensitive to EMI?	No	Yes	Yes	Yes	No
Remote Sensor Power Required?	No	No	Yes	Yes	No
No. of Conductors Required?	2-3C per switch	6 wires (STP preferred)	8-12C for incremental encoders. SSI and other field bus interfaces. (STP preferred)	8-12C for incremental encoders, SSI and other field bus interfaces. (STP preferred)	1 fiber
Maximum Distance	100m	100m	300-500m (depending on type of output drivers and EMI environment)	300-500m (depending on type of output drivers and EMI environment)	2000m
Cost	Medium	Medium	Low-Medium for Incremental Encoders. Medium-High Cost for Absolute Encoders.	Low-Medium for Incremental Encoders. Medium-High Cost for Absolute Encoders.	High

As shown in Figure 10, the Portland (OR) aerial tram is a recent project incorporating the fiber optic encoders. The encoders are used both for speed feedback for the VFD motor drives as well as for monitoring synchronization of the cable drive system at various points.

Comparison table of position sensors. The following table summarizes the advantages and disadvantages of the five major types of position feedback sensors discussed in this paper. In addition, every application typically dictates a preferred type of position sensor, depending upon whether it's a new installation (favors latest technology), an upgrade/retrofit (favors existing or mature technology, usually not the latest) or repair (favors existing technology).

Energy Efficiency

BY USING INNOVATIVE BEARING SOLUTIONS

Claus Müller, Peter Schuster and Oliver Koch

Management Summary

Based on simulation methods and calculation tools developed by the Schaeffler Group and presented in the first part of this paper, three approaches regarding increased efficiency based on rolling bearings are presented.

The first approach addresses the overall bearing concept itself. It shows which bearing concept exhibits the highest potential for reducing friction within the customer's system.

The second approach focuses on reducing the friction of the rolling bearing itself. In this respect, optimization of the internal bearing geometry—as well as of the tribological conditions of relevant friction partners (e.g., roller face versus rib)—plays a key role. Examples used here are low-friction, tapered-roller and deep-groove ball bearings.

The third approach facilitates higher efficiency through downsizing. For example, the load-rating capacity of the Schaeffler Group's new ball roller bearings is enhanced by their ability to place a higher number of rolling elements into the bearing without increasing its size.

Introduction

Rolling bearings and saving energy go hand-in-hand. In other words, the original purpose of a rolling bearing is to save energy by reducing the friction between mechanical parts in movement against each other—be it the rotation of a wind turbine, the wheel of a car or the shafts of a transmission. Accordingly, the rolling bearing is a key machine element with respect to the improvement of energy efficiency of a machine or system. In order to meet growing market demands in this field, the Schaeffler Group develops and manufactures low-friction bearing solutions. Schaeffler's engineering expertise in this respect is based on simulation and calculation tools, understanding and analyzing the customer's bearing-related system as a whole, as well as providing appropriate low-friction bearing components.

Analytical Model for Calculating and Minimizing Friction of Rolling Bearings

There are currently two methods for calculating the friction of rolling bearings.

The first approach is to use the catalog method of the rolling bearing manufacturer and the second is to use highly specialized multi-body simulation (MBS) programs. The catalog method involves the use of empirical approaches. They enable the frictional torque to be calculated quickly for low model accuracy. On the other hand, MBS programs such as the *CABA3D* (Ref. 1), developed by the Schaeffler Group, have a very high model accuracy that require longer calculation times.

In order to combine the advantages of the catalog method and the MBS programs, the Schaeffler Group has developed a new analytical model for calculating rolling bearing friction. This model was implemented in the *BEARINX* (Ref. 2) program so that the new friction calculation is available to a large group of users. Advantages are short calculation times and the consideration of various influencing factors such as real stress distribution and the internal geometry of the bearing. Furthermore, the rolling bearing power loss of entire shaft systems or transmissions can be calculated, as well as load distribution and rating life. Thus it is possible to select an (friction) optimized bearing design, even in the early product development phase.

During this process, *BEARINX* addresses various influencing factors such as the elasticity of the shaft and housing, the contact stresses from non-Hertzian calculation methods and, of course, the internal geometry of the bearing (profiling, osculation, contact angle, etc.). Figure 1 displays an example of a *BEARINX* model of a transmission.

The detailed calculation results and the (internal) bearing geometry are the input variables for the new friction calculation.

Elastohydrodynamic Lubrication

The elastohydrodynamic lubrication (EHL) theory deals with the formation of a lubricant film in the contact points of bodies under high loads when rolling at high speeds (Ref. 3).

The term elastohydrodynamic lubrication involves two phenomena. One, the formation of a hydrodynamic lubricant film, i.e.—the independent build-up of pressure due to the lubricant wedge effect of the flow of a viscous fluid. Two, the elastic deformation of the contact bodies, which, in conjunction with the increase in viscosity of the pressure zone, makes

a significant contribution to the increase in hydrodynamic load-carrying capacity (Ref. 4).

Figure 2 shows the ratios in the EHL contact. Both contact partners undergo elastic deformation during contact. The central lubricant film height h_0 is present in the largest section of the lubrication gap. Contraction occurs on the outgoing side. Here, the lubrication gap is reduced to the minimum lubricant film height h_{min}.

Figure 2 also shows the adaptive pressure distribution in the EHL contact and the elliptic pressure distribution according to Hertz. The pressure builds up slowly on the incoming side. In the area of the central lubricant film height, the pressure progression almost corresponds to the pressure progression calculated according to Hertz. A sharp increase in pressure occurs on the outgoing side due to the narrowing of the gap.

Frictional Components

The friction in a rolling bearing is made up of several components—rolling and sliding friction and churning losses.

A rolling friction component is the outcome of lubricant compression in the inlet zone of the EHL lubricant film (Fig. 2). A further component of rolling friction is material hysteresis. When the rolling elements roll on the raceway, the areas in front of the rolling element are deformed and the material compresses. When the material is unloaded, only a portion of the energy is used for the rolling motion. The remainder is converted into heat, due to internal material friction.

In general, sliding occurs in all contact points of a rolling bearing; e.g., between rolling element and raceway or cage. This can involve macro slip or micro slip. What is known as a differential slippage always occurs in ball bearings due to the varying distance of the individual contact area points of the axes of rotation of the bearing elements. This means that the center section of the ball surface slides in the opposite direction of the direction of rolling and that the external sections slide in the direction of rotation.

A further sliding friction component is the spinning friction. This is caused by slippage that occurs when a rolling element (a ball in this case) turns on the vertical axis of its contact (Fig. 3).

Churning losses caused by lubricants occur in the bearing along with rolling and sliding friction. These losses are highly dependent on the quantity of oil or grease found in the bearing and adjacent construction, and cannot be analytically calculated according to the state of the art. It is for this reason that we acted on the assumption that the bearings were lubricated with a minimum quantity of oil below.

New Friction Model for *BEARINX* and Validation

Viscoelastic and nonlinear viscous effects were taken into consideration in the friction model developed for *BEARINX*.

Each contact must be taken into account individually in order to calculate the collective spinning friction and the influence of differential slippage on the frictional torque of rolling bearings. In turn, the local increase in temperature affects the viscosity and thus the frictional force. This means that the calculation must be iterative at this point. After successful iteration, all frictional forces on the discrete points of the contact surface—as well as the distribution of tempera-

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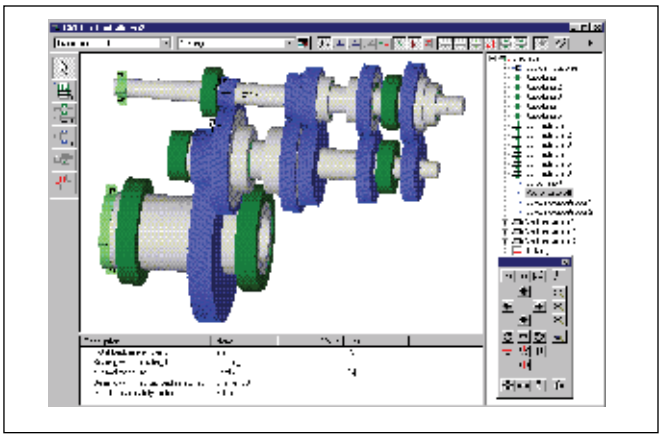

Figure 1—Model of a passenger car manual transmission in *BEARINX*.

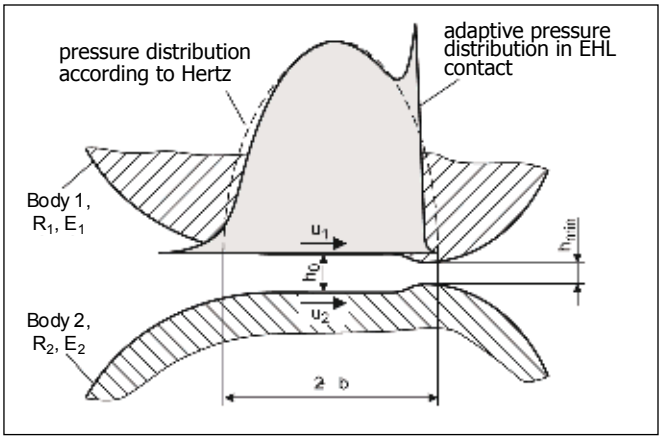

Figure 2—Elastohydrodynamic contact (Ref. 5).

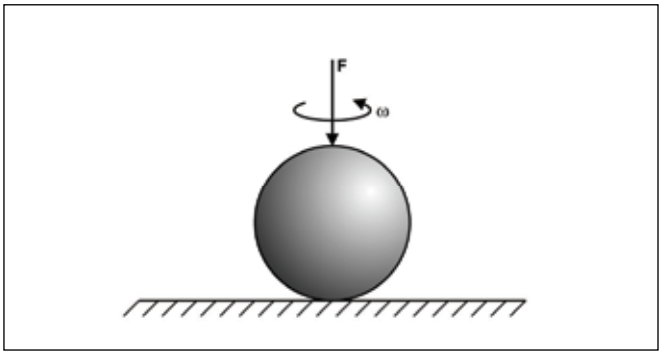

Figure 3—Spinning friction illustrated with ball/plane.

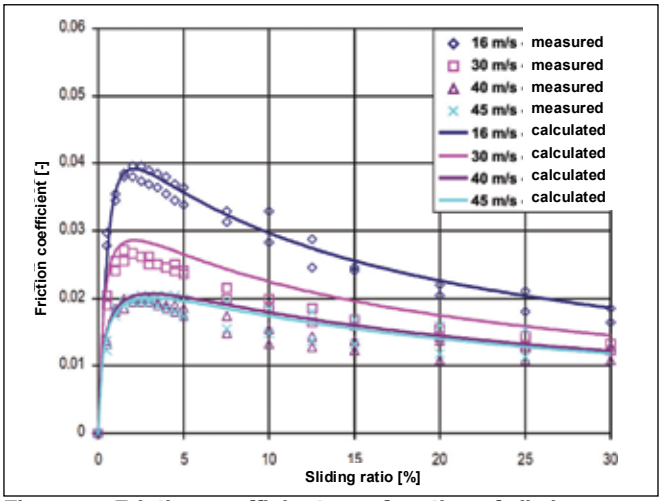

Figure 4—Friction coefficient as a function of slip increase: comparison of measurement and calculation.

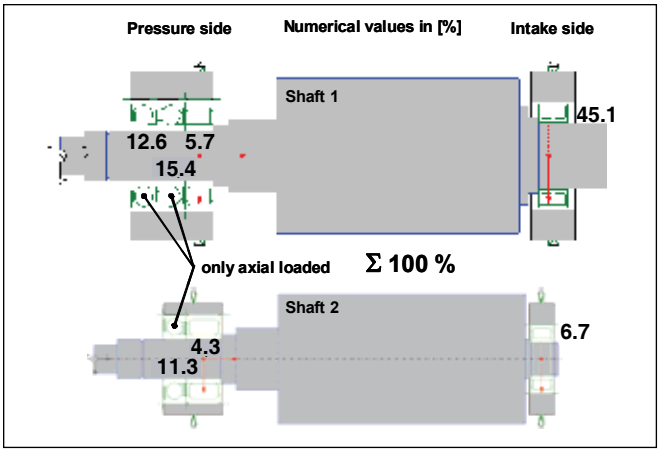

Figure 5—Relative portion of the individual bearings on the total frictional torque of compressor Shafts 1 and 2—initial condition (Authors' Note: pressure side is left; angular contact ball bearings do not carry radial load; all numbers in %).

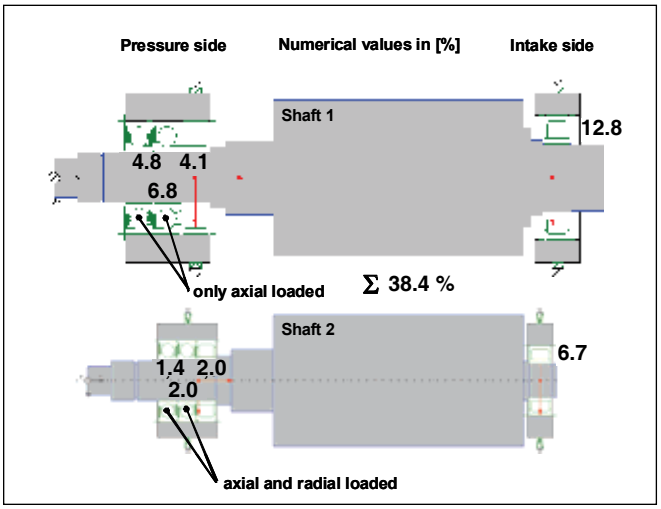

Figure 6—Relative portion of the individual bearings of the total frictional torque of compressor Shafts 1 and 2—variant with optimized friction characteristics.

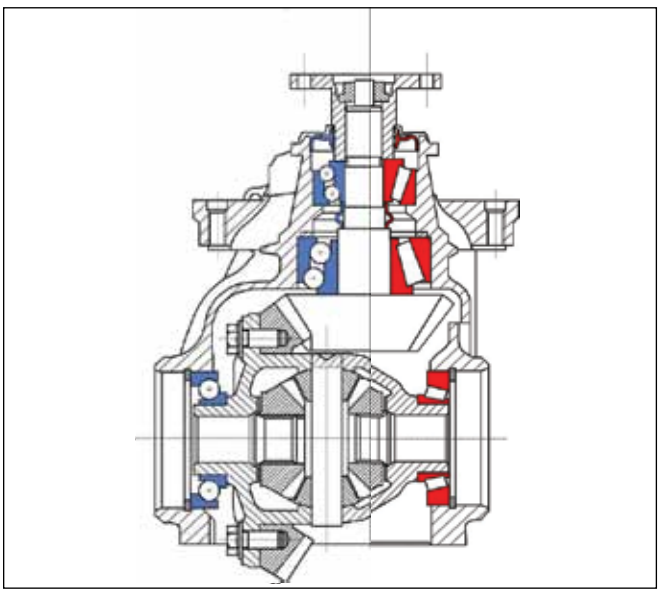

Figure 7—Tandem ball bearing (blue) versus tapered-roller bearing (red) in rear-axial differential transmission.

ture increases—are available in the calculation results.

The redeveloped method for calculating friction with *BEARINX* was comprehensively validated. During the first phase, friction measurements from 2-disc test rigs were used for the validation. Figure 4 shows the coefficient of friction as a function of the slippage for various accumulated speeds. The measurement values are shown as points and the calculated friction values as the continuous line. The decrease in the coefficient of friction is based on thermal effects. The correlation between measurement and calculation can be assessed as very good. This shows that *BEARINX* is capable in principle of calculating the coefficient of friction of a single-defined contact correctly—both qualitatively and quantitatively.

In the final step of the validation, frictional torque values of rolling bearings were calculated with *BEARINX* and compared with measurements. It was shown that the correlation between the frictional torques, calculated using *BEARINX*, and the measurements is significantly greater than the correlation between the frictional torques calculated using the catalog methods of major rolling bearing manufacturers and the measurements (Ref. 6).

Bearing Concept for Customer Applications with Optimized Friction Characteristics

In order to identify the best low-friction solution for the customer, the new *BEARINX* friction calculation enables the assessment of bearing concepts and friction reduction potentials in the early phases of customer product design and development.

The potential provided by the new *BEARINX* friction calculation are shown below by means of a practical example. Figure 5 shows both shafts of a compressor. Shaft 1 is supported on the pressure side by cylindrical roller bearings and two angular contact ball bearings. On the intake side, it is supported by a double-row cylindrical roller bearing in a housing. Both angular contact ball bearings have radial release, which means that they are subjected to axial load only. The radial load is supported by both cylindrical roller bearings. The bearing support of Shaft 2 is designed in the same way. Due to the lower forces, only one angular contact ball bearing has been used and the cylindrical roller bearing on the intake side is a single-row bearing.

The task involves minimizing the bearing friction of the compressor and the boundary conditions regarding rating life, rigidity and space must be met.

To begin, the friction for all bearings in the initial condition shown in Figure 10 is calculated. If the total bearing friction equals 100%, it is possible to determine the relative portion of each bearing of the total frictional torque. This means that it is possible to quickly identify those bearings that have the largest potential for savings. Figure 5 shows that in this case the double-row cylindrical roller bearing and the angular-contact ball bearings together generate 84.3% of the bearing friction.

The first step involves optimizing the bearing selection and arrangement. The double-row cylindrical roller bearing that generates 45.1% of the losses can be replaced by a smaller, single-row cylindrical roller bearing. This means that the required space at this bearing position can be reduced by over 20%. The cylindrical roller bearing on the pressure side

of Shaft 1 can also be replaced by a smaller cylindrical roller bearing.

The cylindrical roller bearing on the intake side of Shaft 2 remains unchanged. A smaller, cylindrical roller bearing is now used on the pressure side. The angular-contact ball bearing is replaced by two smaller versions that do not have a radial release. This means that the radial load is split across all bearings on Shaft 2. The friction is reduced, since smaller bearings are used, and in the case of the angular contact ball bearings, the contact angle of the bearing is more favorable due to the combined loading. At the same time, 25% less space is required. Overall, the bearing friction can be reduced by 35.4% during the first stage of optimization.

During the second stage the osculation of the angular-contact ball bearings is optimized for this application. This enables a further reduction in friction of 11.3%.

The last stage involved investigating the influence of surface roughness on the frictional torque. In this case, it was possible to reduce the friction by a further 14.9% by optimizing the design of the surface. Figure 6 shows the bearing support with optimized friction characteristics and the friction at individual bearing positions. All percentage values refer to the total bearing friction of the original variant. By using *BEARINX* the friction can be reduced by 61.6%—compared with the original variant—while simultaneously reducing the space required for the bearing supports (Ref. 7).

The use of modern rolling bearings in the automotive industry also significantly increases efficiency and reduces fuel consumption and emissions. The Schaeffler Group offers an alternative to conventional tapered-roller bearings for the drivetrain and chassis in automotive applications with low-friction double-row or four-row angular-contact ball bearings (Figs. 7–8). Note that the diagram shown in Figure 8 is based on a shaft rotation of 50 rpm. The bearing friction, which is up to 50% lower in, for example, wheel bearings or in final drive units of passenger cars, reduces the overall consumption by up to 1.5%.

Low-Friction Rolling Bearings

This approach deals with the reduction of the friction of the rolling bearing itself. In this respect, optimizing the internal bearing geometry as well as the tribological conditions of relevant friction partners (say, roller face versus rib) plays a key role. For example, the friction torque of the Schaeffler Group's new tapered-roller bearings with optimized friction characteristics was reduced by more than 70% compared to conventional tapered roller bearings (Fig. 9).

A second example of a low-friction product is Schaeffler's Generation C deep-groove ball bearings. These exhibit improved raceway features like roundness, waviness and roughness as well as tighter tolerances for raceways and balls.

This means that the bearing life can be increased for identical operating conditions. Part of this increase can be transformed into a reduction of friction by increasing the osculation of the outer bearing ring; thus it was possible to reduce the friction of this new generation of deep-groove ball bearings by about 35% for the unsealed version (Fig. 10). In addition, Figure 10 shows that using a plastic cage offers the best reduction in friction, while using a steel cage offers the

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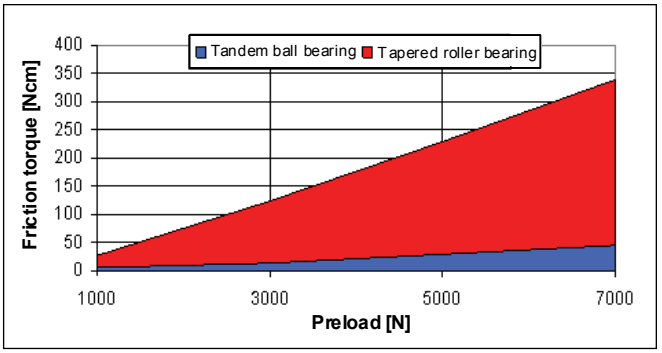

Figure 8—Friction torque as function of preload for bearing concepts shown in Figure 7, measured during transmission assembly (shaft rotation 50 rpm).

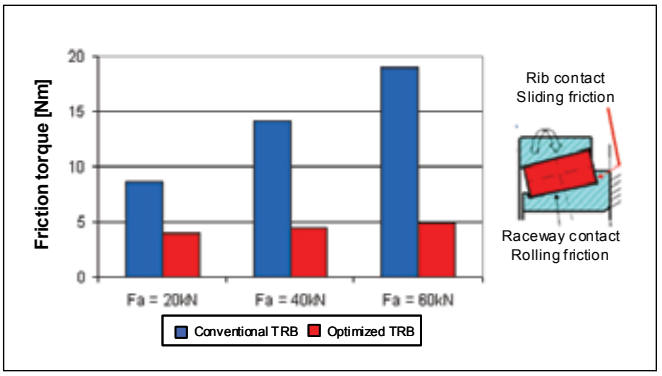

Figure 9—Comparison of relative frictional torque for tapered-roller bearings (TRBs) under various axial loads. By optimizing the rib contact, Schaeffler TRBs (red) exhibit significantly reduced friction compared to conventional TRBs (blue).

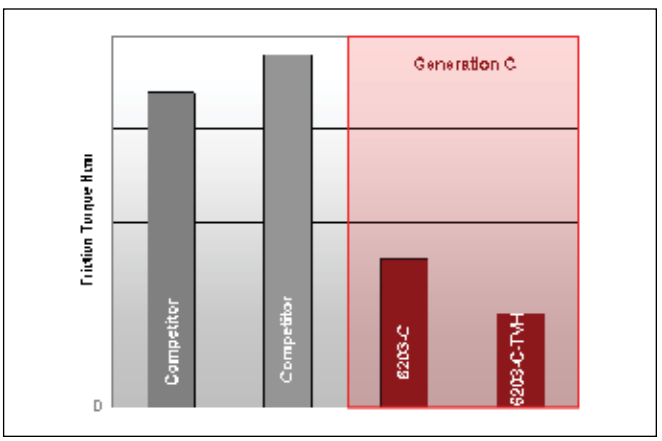

Figure 10—Benchmarking Schaeffler/FAG's new Generation C unsealed 6203 deep-groove ball bearings, both with steel and plastic cages.

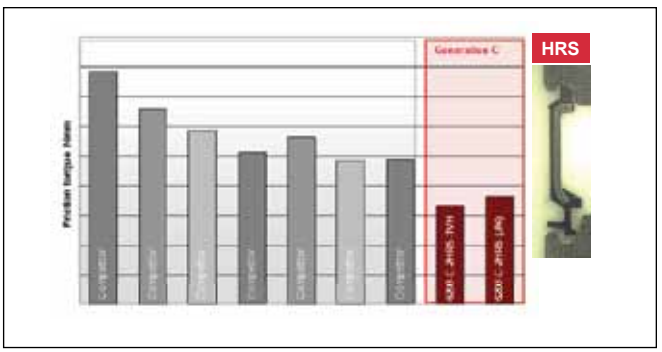

Figure 11—Comparison of 6203 (sealed) versus 6203-C-2HRS: FAG's Generation C bearings equipped with special HRS sealings (right) are the benchmark, with the lowest frictional torque in test.

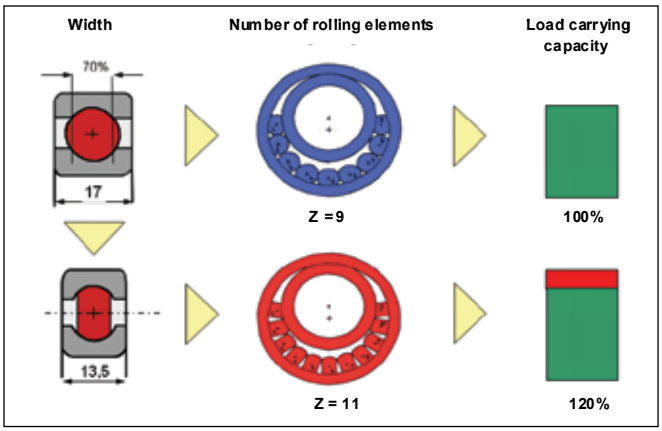

Figure 12—Compared to a deep-groove ball bearing (top), Schaeffler's new ball roller bearing (bottom) is smaller and has a higher load-carrying capacity due to a higher number of rolling elements.

Figure 13—Deep-groove ball bearing 6207 with 9 balls; ball roller bearing BXR 207 with 11 rollers; ball roller bearing BXRE 207 with 14 rollers.

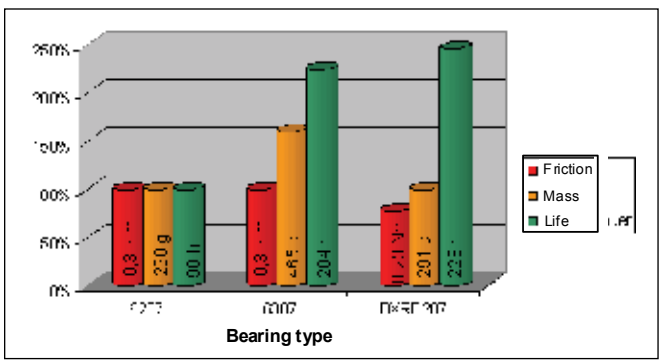

Figure 14—Schematic comparison of friction torque (red), mass (orange) and life (green) of bearing types described in Figure 13 and Table 1—increased power density facilitates downsizing.

Table 1—Load-carrying capacity (dynamic *C* and static C_0) of ball-roller bearing BXRE 207 compared to deep-groove ball bearing 6207 of same size, as well as to larger deep-groove ball bearings 6208 and 6307 (*d*, *D*: inner and outer diameter, *w*: width).

Type	Size [mm] d/D/w	C [N]	C_0 [N]
6207 BXRE	35/72/17	25.500	15.300
6207	3/72/17	34.500	23.800
6307	35/80/21	33.500	19.000
6208	40/80/18	29.000	18.000

best noise reduction by means of damping.

By developing and applying an improved, high-speed rubber sealing—i.e., HRS—the sealed variant of Generation C deep-groove ball bearings shows excellent friction performance, compared to competitor products (Fig. 11).

Efficiency through Downsizing

This approach facilitates higher efficiency through downsizing. For example, the load-carrying capacity of Schaeffler's new ball roller bearing is increased by the ability to place a higher number of rolling elements into the bearing without increasing its size. This is achieved by slicing the ball on two of its non-load-carrying sides (Figs. 12–13). A "new" type of rolling element is created—a "ball roller." The resulting higher power density of this ball roller type bearing—i.e., or BXR—is illustrated in Figures 13–14. It enables the customer to select a smaller-size bearing with the same performance, but with significantly reduced friction. Both dynamic and static load-carrying capacity of ball- roller bearing BXRE 207—compared to deep-groove ball bearing 6207 of same size as well as to larger, deep-groove ball bearings 6208 and 6307—are shown in Table 1. For example, if the customer system allows for a smaller shaft diameter, the larger 6208-type can be replaced by the smaller BXRE 207 while increasing load-carrying capacity at the same time.

Conclusion

Rolling bearings and energy savings are symbiotic. The original purpose of a rolling bearing is to save energy by reducing the friction between mechanical parts in movement against each other. Accordingly, the rolling bearing is a key machine element with respect to the improvement of energy efficiency of a machine or system.

It has been proved that the Schaeffler Group can meet growing market demands in this field by establishing benchmarks for calculation tools for customer system analysis and overall bearing concept assessment. In combination with newly developed and qualified low-friction rolling bearings, or Generation C deep-groove ball bearings, it is possible to provide customers a complete low-friction solution. The example of Schaeffler's new ball-roller bearing shows that downsizing is an excellent approach to improving energy efficiency.

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The Case for Hollow-Shaft Torque Motors

PERMANENT-MAGNET, SYNCHRONOUS-TORQUE MOTORS OFFER SIGNIFICANT ADVANTAGES ON HIGH-ENERGY-CONSUMING AND HIGH-DYNAMIC APPLICATIONS.

Harald Poesch, Siemens product marketing manager, servomotors

Hollow-shaft torque motors are used in a wide variety of machinery.

Today's machine designer must evaluate more factors than ever in approaching a new project. Likewise, the integrator and retrofit engineer have expanded options—not only as a result of new technologies but also because of critical areas of focus such as reduced energy consumption, faster assembly time, vendor consolidation and smaller footprint achievement.

In the realm of motion control, one type of motor with a relatively short history has made significant advancements that necessitate a new look at its potential in many application areas. These applications range from machine tool rotary tables to various packaging, printing, converting, extruding, papermaking, plastic film and materials handling machinery—i.e., anywhere direction must be reversed with a very high degree of accuracy, zero backlash (hysteresis) and the maintaining of motion control—contrasting the necessary decoupling of a conventional motor and gearbox.

Enter the often-overlooked permanent-magnet, synchronous-torque motor.

Hollow-shaft torque motors offer various design integration options coupled with advanced performance features for greater energy-efficiency, substantial component reduction and significantly smaller footprints in today's machine drivetrains.

Torque motors are direct drives built for rotary axes where high torque and high precision are required at relatively low speeds. With their significantly lower installation time, maintenance requirements, component part count and space allowance, these motor types are frequently viable alternatives to geared motors.

Two popular varieties of torque motors exist today:

Complete-torque motor—requiring only direct flange mounting to the machine and connection of the rotor to the machine shaft

• Built-in-torque motor—the stator and rotor are supplied as individual components that are directly integrated into the machine mechanics

• Complete-torque motors are often found on extruder main drives, feed heads on injection molding machines, roller drives on papermaking machines, wire drawing devices, textile machine web stretching and winders/cross cutters on packaging equipment.

Built-in-torque motors are typically used on machine tool rotary tables, swivel axes, dynamic tool turrets and turning spindles as well as printing press cylinders, chill rolls in cast film and foil stretching machines, indexing tables in metal-forming presses and all other types of high-dynamic, high-precision path and speed control applications.

A similarity is that both types of torque motors feature a hollow shaft, thus allowing media and/or mechanical components to be guided through the rotor cavity.

Torque motors are multiple-pair-pole-synchronous motors, similar in operation to rotary-synchronous-servo motors. The rotor is equipped with permanent magnets, while the stator contains the motor windings. The high number of pole pairs leads to a design generating high maximum torque at low speeds. In the past, since eddy current losses increase with the number of pole pairs and the running speed of the motor, torque motors were considered applicable only at relatively low speeds. But new water-cooled designs have countered this principle, allowing a high power density. Today's torque motors can accommodate speeds of 1,000 rpm or higher.

As a result of these higher-pole-pair designs—and because many mechanical power transmission components that generate backlash, heat, friction and noise are eliminated—torque motors offer these benefits to designers:

- small footprint = high torque density
- excellent rotational accuracy and repeatability = direct load control
- space-saving machine designs = elimination of gear units and belt transmissions
- low maintenance = fewer mechanical parts in the drivetrain
- high energy efficiency = mechanical losses in the drivetrain are eliminated

While higher in cost than geared motors, it is currently estimated that torque motors offer the designer a payback of three to four years in energy

continued

savings alone, which does not include the immediate, increased performance and upfront cost savings—both in installation and maintenance. Obvious vendor reduction and inventory advantages are also realized through the use of these motors.

On a typical multi-layer blown-film line, for example, the use of torque motors can reduce the footprint of the extrusion section by half, and the consumed production space decreases accordingly, leading to an increase in production rates per square foot.

Torque motors were also long-thought to be susceptible to chemical and other ambient atmospheric contamination, but new designs have been adapted to withstand corrosive atmospheres such as a paper mill dry hood, for example; and, being water-cooled, they are performing satisfactorily in many harsh environments without heat damage. Enclosures are available up to an IP54 rating, with overload capability up to 2.5 times the rated torque.

Typical applications for today's advanced torque motors include (from top) converting equipment, printing presses and machine tool rotary tables.

Torque motors reduce mechanical efficiency losses to an absolute minimum because they eliminate mechanical transmission in the drivetrain. Compared to geared motor solutions, the efficiency gain is typically in the range of 10 percent, while the gain is closer to 70 percent when hydraulic motors are replaced in applications such as injection molding machines. Further, due to the direct and constant control of the load shaft on torque motors—with no backlash or decoupling occurring—a significantly higher precision in motion is achieved. This is not possible in a geared or belt-driven solution.

For example, in the production of stretched film, torque motors used with chill rolls, pull rolls, stretch rolls and winders have resulted in dramatic improvement in production quality. Because the likelihood of cracks in the web is minimized, a more accurate speed control of the direct-driven rolls results in faster start-ups during the changeover from one film product to another. In addition, the higher control accuracy enables the production of a thinner film that is 10 times more consistent in its thickness. Likewise, the stiff drivetrain configuration achieved with torque motors allows faster ramping up and down in cyclic applications, leading to shorter cycles and increased product output in the same time period. In many applications with very short cyclic times—such as indexing tables or injection molding machines—the changeover from conventional drives to direct-driven solutions has resulted in production increases of 25–30 percent, typically. These results indicate that a lower component count now means a lower product lifecycle cost as well as reduced potential failure rates in the field.

Other features on today's torque motors that make them more appealing for the machine designer include:

- absolute value or incremental encoders, or resolvers for enhanced motion control
- electronic nameplate for faster commissioning
- horizontal or vertical mounting options
- bearing options for axial-thrust applications
- PTC resistors in each phase, in addition to standard KTY thermistors for optimum temp monitoring

Mechatronics is also critical for direct drives such as torque and linear motors in the integration process because the electronic machine control protocols are so crucial in monitoring and executing the electromechanical motions. A keen knowledge of mechanical, electrical and electronic engineering is fundamental in determining the proper unit to suit the load. Mechatronics addresses such topics for the machine builder as proper encoder location, reaction versus dynamic force calculations and how best to integrate a high-dynamic direct drive mechanically into the machine.

Additionally, through various advanced computerized simulation techniques, mechatronic performance can be validated, and troubleshooting on the design can be accomplished before the first machine is ever built. Even in the field, before and after a retrofit or rebuild, the mechatronic services currently available can be used for product application determination, full performance analysis and controls compatibility. While the performance of a new motor or drive might be deemed satisfactory by mechatronic analysis, other mechanical, electrical or electronic components might be found lacking. It is precisely this comprehensive, integrated approach that is fast-earning mechatronics its place in the overall scheme of machine development and utilization.

In conclusion, with today's emphasis on cost containment, energy efficiency and higher productivity on every type of machine design, it is imperative that all viable options be explored. In designing the drivetrain on many machines, the advantages of torque motors described in this paper will have a positive impact on the overall project results. Torque motors can offer great flexibility in design, retrofit and rebuild applications, and they have expanded capabilities that justify their implementation on more types of machines.

For more information:

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calendar

September 6–8—International Conference on Electrical Machines. Crowne Plaza Rome-St. Peter's Hotel, Rome. The ICEM is a biannual event in its 19th edition devoted to electrical machines. A community of specialists discusses the progress achieved and the future developments in technologies, analysis, design, testing, operations, practical applications, maintenance and teaching in this field. Conference topics have been divided by tracks, each of which has two co-chairs or more for reviewing. Topics include conventional machines; non-conventional machines; electrical drives; materials; theory, modeling and design; measurement, testing, losses and efficiency education; embedded applications; and grid-connected and emergency applications. For more information, visit *www.icem2010.it*.

September 9–10—International AVL Engine and Environment Conference. Helmut-List-Halle, Graz, Austria. This conference, held by Austrian powertrain developer AVL, looks at the innovative internal combustion (IC) engine in the context of powertrain electrification as a major key to long-term carbon dioxide reduction. Exploration of the potential of IC engine powertrains is a major topic, and developments necessary to enable current niche solutions to enter the high-volume market will be discussed. The following issues will also be looked at: IC engine innovations; optimization of the IC engine as the strategy of major OEMs for the next 20 years; ecology and economics of different technologies; the battery as an obstacle or chance on the way to the high-volume electric drive; electric vehicles with and without range extenders; software; and the transmission as a system enabler. For more information, visit *www.avl.com/engine_environment*.

September 21–23—Atlantic Manufacturing Technology Show. Exhibition Park, Halifax, Novia Scotia. The Atlantic Manufacturing Technology Show (AMTS) brings manufacturers together to connect on new technology and new products. The Atlantic Canada region is home to more than 2,600 manufacturing companies employing nearly 24,000 workers. AMTS will bring together diverse industries such as aerospace, defense, heavy equipment, mining, energy, wood products, machinery and metal fabrication. For more information, visit *www.sme.org/amts*.

September 29–October 2—EPTDA Annual Convention. Malta. The European Power Transmission Distributors Association's (EPTDA) 13th Annual Convention is expected to attract over 250 qualified decision makers and guests in the power transmission and motion control industry. Under the theme "Our Future," the summit will focus on traditional business approaches. The location, Malta, is strategic for international business in the Mediterranean, at the crossroads of Europe, North Africa and the Middle East. Highlighted speakers include Daniel Burrus, a technology forecaster and business strategist, who will discuss original tips for overcoming obstacles and acting on new opportunities. Alan Beaulieu, of the Institute for Trend Research, is the closing keynote speaker. Hands-on sessions will complement the educational program for the first time. EPTDA members and convention delegates will visit local operations of power transmission/motion control international corporations, including Lufthansa Technik Malta Ltd., Trelleborg Sealing Solutions Malta, Methode Electronics Malta and Hetronic Malta Ltd. For more information, visit *www.eptda.org/events/annual-convention.html*.

October 5–7—North American Offshore Wind Energy Conference and Exhibition. Atlantic City, NJ. The North American Offshore Wind Energy Conference and Exhibition will provide opportunities for networking, learning and collaborating. The event includes an exhibit floor, posters, technical sessions, business and policy sessions, as well as an offshore supply chain track. The supply chain track will examine the needs, opportunities, barriers and challenges to manufacturing, transporting and constructing off-shore wind turbines. For more information, visit *www.offshorewindexpo.org*.

October 12–14—The Business of Plugging-In. Detroit Marriott at the Renaissance Center, Detroit. Detroit's second annual plug-in electric vehicle (PEV) conference brings together a mix of leaders from the automotive, utility, academic, finance and new technology industries for three days of business development, education and networking. Hosted by the Center for Automotive Research in partnership with presenting sponsors, DTE Energy and General Motors Company, the conference will offer the latest information on the business side of plugging in from leaders in the various industries. For more information, visit *www.bpiconference.com*.

October 20–21—Manufacturing Innovations–Aerospace/Defense. Gaylord Palms, Orlando, FL. This exhibition is exclusively designed for aerospace and defense manufacturers and suppliers, addressing an expanding market with specific needs for innovation, precision, accelerated production and improved quality. The event will be co-located with the Aerospace Measurement, Inspection and Analysis Conference. For more information, visit *www.sme.org/aerospacedefense*.

Timken

WINS $26 MILLION WIND CONTRACT WITH GOLDWIND

The Timken Company has received a contract worth $26 million to supply wind turbine products and services to China's Xinjiang Goldwind Science & Technology Company. In 2009, Goldwind received new wind power capacity orders for about 2,722 megawatts, accounting for approximately 19.7 percent of the wind generation added in China last year. Goldwind's contract with Timken will support more than 1,500 megawatts of new wind power capacity, with a broad scope that reflects Timken's long-term commitment to develop wind energy technology. It will contribute to the company's expansion in the industry, with Timken providing engineering support, advanced bearings that include the new Timken UltraWind tapered roller bearings and condition-monitoring systems and services for Goldwind's current 1.5-megawatt and 2.5-megawatt platforms. The companies also will collaborate on future wind-turbine developments.

"The collaboration between our companies brings together two leaders developing advanced technologies for efficient, green power generation," says Leong Fang, president of Timken China. "Combining Timken's century of experience with Goldwind's leading innovation in large-scale wind turbines, we are prepared to serve China's needs for renewable energy, and to promote global development as well."

Christopher Coughlin, president of Timken Process Industries, adds, "The opportunity to support Goldwind's leadership on these platforms plays to Timken's strength: engineering sustainable systems for large turbines, from a range of proprietary materials to a breadth of power transmission products and services for the extended life of the equipment."

Coughlin noted the companies have agreed to collaborate further on development programs, including using Timken's advanced engineering design to reduce cycle times for new platforms and incorporating the company's "life cycle" service approach to contribute to sustainable performance and uptime of Goldwind's projects around the world. "We've established wind power manufacturing and service capabilities on three continents, which is important as Goldwind looks to grow globally," Coughlin says.

Bison Gear

ACQUIRES VON WEISE OF CANADA

The brushless DC electric motor business of Von Weise of Canada Company was acquired by Bison Gear and Engineering Corp. The product line includes low voltage (12–24 volt) BLDC motors ranging from 80 to 225 watts with integral multifunction speed controls.

"With increased requirements for greater energy efficiency, compact size and overall value, we see brushless motor applications and the market growing significantly for our customers and Bison," says Martin Swarbrick, Bison Gear CEO. "This is a perfect complement to our own new Autonomotor sensorless brushless product line, and it aligns with our growth strategy, balancing internal product development with product and technology acquisition."

The Von Weise motors were originally developed for the mobile HVAC market and will be incorporated into Bison's gearmotor product line for industrial and commercial applications.

"We have relocated the production of these new motors to our St. Charles, Illinois facility where we anticipate the synergy with our gearmotor products will lead to increased employment opportunities," says Ron Bullock, Bison Gear chairman. "This expansion of our brushless DC motor manufacturing is another significant new development for

Bison in our 50th anniversary year."

According to John Morehead, Bison's vice president, strategic planning and marketing, "We look forward to continuing to serve the mobile HVAC market for these products, in addition to the industrial pumps and compressors, valve actuators, medical device and business equipment markets for which they have been designed."

Beckhoff

ESTABLISHES U.K. SUBSIDIARY

Stephen Hayes

Hayes Control Systems has been acquired by Beckhoff Automation in order to expand and intensify Beckhoff's growth in the British market. Hayes was renamed Beckhoff Automation Ltd.

Beckhoff has been represented exclusively by Hayes Control Systems in the U.K. industrial market since 1994. Stephen Hayes, the founder of Hayes Control Systems, was named managing director of the branch. In addition, the 13-member staff is being retained in its entirety.

"Great Britain and Ireland are strategically important markets for Beckhoff, as numerous international companies have their headquarters and make global decisions here," says Kai Ristau, international sales manager at Beckhoff Automation. "Therefore, it is naturally important for us to

continued

have a strong local presence with a skilled Beckhoff team."

Hayes comments, "Based on the good business development of Hayes Control Systems in recent years, we see added growth potential by expanding our sales in Great Britain and Ireland. Our marketing strategy is to concentrate on areas in which we can offer our customers decisive benefits with our technological innovations."

Papers

INVITED FOR ROLLING ELEMENT BEARINGS SYMPOSIUM

The 2011 ASTM International Symposium on Roller Element Bearings is accepting papers. The symposium is sponsored by the ASTM International Committee F34 on Rolling Element Bearings; it is held in conjunction with the April 2011 standards developments meetings of the committee, April 13–15, 2011, at the Marriott Anaheim in Anaheim, CA.

The symposium provides an international forum for information exchange on recent achievements in bearing technology. It will begin with a roundtable session discussing the testing methods and specifications of ASTM Committee F34, followed by a series of papers presented by leading experts. A Bearing Technology Exhibit will be held and consists of a series of booths displaying different products, the latest bearing advances, manufacturing capabilities, materials, products that influence bearings and more.

Attendees include bearing manufacturers, bearing users, bearing parts manufacturers, lubricant suppliers, customers and consultants.

Interested presenters or authors must submit a 250–300 word abstract online (*www.astm.org/F34symp511.htm*) by August 31, 2010. Accepted papers will be established by October 31. Symposium presenters are required to submit their papers to the Journal of ASTM International (JAI), unless officially exempted by the symposium co-chairs. JAI is an online, peer-reviewed journal for the international scientific and engineering community. For more information, visit *www.astm.org/F34symp511.htm*, or Hannah Sparks, at *hsparks@astm.org*.

Robotic Sales

CLIMB IN 2010

North American based robotics companies saw orders jump 40 percent in units in the first half of 2010, according to new figures released by Robotic Industries Association (RIA), the industry's trade group. A total of 6,316 robots valued at $411.4 million were ordered by North American companies through June, a rise of 40 percent in units and 48 percent in dollars over the same period in 2009. When orders to companies outside of North America are included, the increases are even larger, up 54 percent in units and 62 percent in dollars.

"In North America, the biggest gains came in orders by non-automotive companies, where units rose 51 percent," says Jeffrey A. Burnstein, President of RIA. "This is a very positive sign for our industry as it continues to expand into a wide-range of industries such as semiconductor, electronics & photonics, food & beverage, plastics & rubber, consumer goods, and life sciences. Each of these market segments posted substantial gains in the first half of 2010, while automotive orders also grew 30 percent."

Burnstein noted that comparisons to 2009 look especially strong since last year's numbers were down significantly due to the recession. "We still have a long way to go before the industry is back to pre-recession sales levels, but I'm very encouraged that we're headed in the right direction," Burnstein adds.

Among leading robot applications, arc welding showed a 52 percent gain in units, followed very closely by material handling, up 51 percent. "Material handling continues to be the largest application area for robots, so this big jump in the first half of the year is excellent news," says Burnstein.

Burnstein also noted that material handling robot sales will likely get a further boost when RIA colocates its Automate

2011 trade show (formerly International Robots, Vision & Motion Control Show), with ProMat, a leading trade show for the material handling and logistics industries sponsored by the Material Handling Industry of America. The events take place March 21–24, 2011 at McCormick Place in Chicago.

"There's growing interest in robotics from the warehousing & distribution industries, which are among the major audience segments at ProMat," Burnstein said. "There are mobile as well as stationary robot applications for these industries, and we're also seeing robot arms put on mobile bases. We see major growth opportunities here for our members which makes this colocation very exciting."

RIA estimates that some 198,000 robots are now at work in U.S. factories, placing the United States second to Japan in overall robot use. More than one million robots are now being used worldwide.

Vacon China

WELCOMES MANAGING DIRECTOR


Pertti Rajamäki

Pertti Rajamäki has been appointed managing director of Vacon Suzhou Drives, effective September 2010. Rajamäki currently serves as regional general manager of Vacon's sales in the Asia-Pacific region. Timo Harri is currently the managing director of Vacon China, and he is set to return to the parent company in Finland in fall 2010.

"During the past few years, Vacon's sales and marketing organization in Asia-Pacific has significantly increased Vacon's revenues in the region," Rajamäki says. "We live in exciting times in China, and I look forward to continuing the work my predecessors have started. Especially, opening the new factory in Suzhou is one of the most important tasks in near future."

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Gear Manufacturing

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Gear Manufacturing

THE JOYS OF TINKERING

Wheelie Car Competition Helps Develop Future Engineers

Call it a generation gap. Kids today know very little of the joys of tinkering. "Sure, they know how to wiggle their thumbs with the latest Wii game," says Julian Pate III, director of education at Focus: HOPE, a renowned civil and human rights organization located in Detroit. "But many don't know the joys of building something from scratch in the basement with your father or uncle like we did growing up. We're trying to put some excitement back into using your hands."

With funding provided by the SME Education Foundation, a team of 8th graders from Robeson Academy on Detroit's West side participated in an engineering project earlier this summer to build electric wheelie cars. The Shop Rat Foundation, a Jackson, Michigan-based nonprofit educational institution, loaned the Robeson Academy two wheelie car kits for this seven-week program.

"Hope for tomorrow starts with hands-on projects today. That's how I think we feel about the program," says Chris Salow, founder and executive director of the Shop Rat Foundation. "We want to encourage everyone to become involved and donate to their local school efforts. We realize the need to intellectually challenge kids at a young age."

The electric wheelie cars featured alternative energy, zero-turn steering, electric motors and dynamic braking. Students had full access to blueprints, the complete frame package, the electrical system, the wheel/axle/tire assembly and other components. They assembled the cars over a seven-week period with mentoring assistance from five engineering students from Focus: HOPE as well as access to the organization's engineering/manufacturing training facility.

While the students learned a great deal of manufacturing and engineering during the seven-week program, the biggest payoff took place in June at the Michigan International Speedway in Brooklyn, Michigan.

"Our students were not told at the beginning of the project that the two teams would be racing the wheelie cars against each other in the shadow of the grandstands at the Michigan International Speedway," Pate says. "Here they were with NASCAR fans stopping by to watch and cheer them on. It was a once-in-a-lifetime opportunity to stand out on the race track with the big boys."

If there were any nerves or signs of fear, Pate says the students played it cool during the race. "These are 8th graders, so it was really no big deal to them. They were urging their teammates on during the competition and really wanted to win. It was great to see this progression from assembling the car kit in the classroom to crossing the finish line at the race track."

Earlier in the year, *Education Week* magazine had graded Michigan K-12 education a "D" due to a litany of issues. Collaborations between the SME Education Foundation, the Shop Rat Foundation and Focus: HOPE aim to challenge assessments like this.

"These kids enjoyed the process, start to finish. They built the cars, they had an opportunity to race the cars on a professional track and they had a once-in-a-lifetime experience. It carries a strong message in this city…working together for the common good," Pate says.

The organizations will continue to work together on engineering and manufacturing initiatives in the future.

For more information visit, *www.shoprat.org*, *www.smeef.org* or *www.focushope.edu*.

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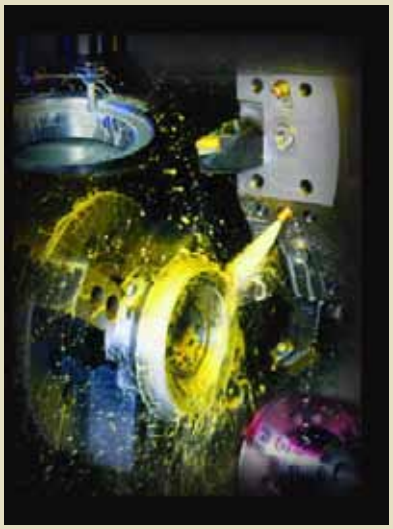

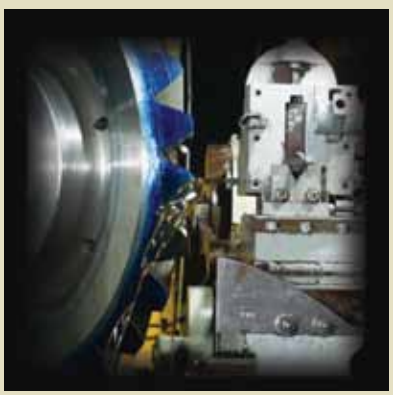

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