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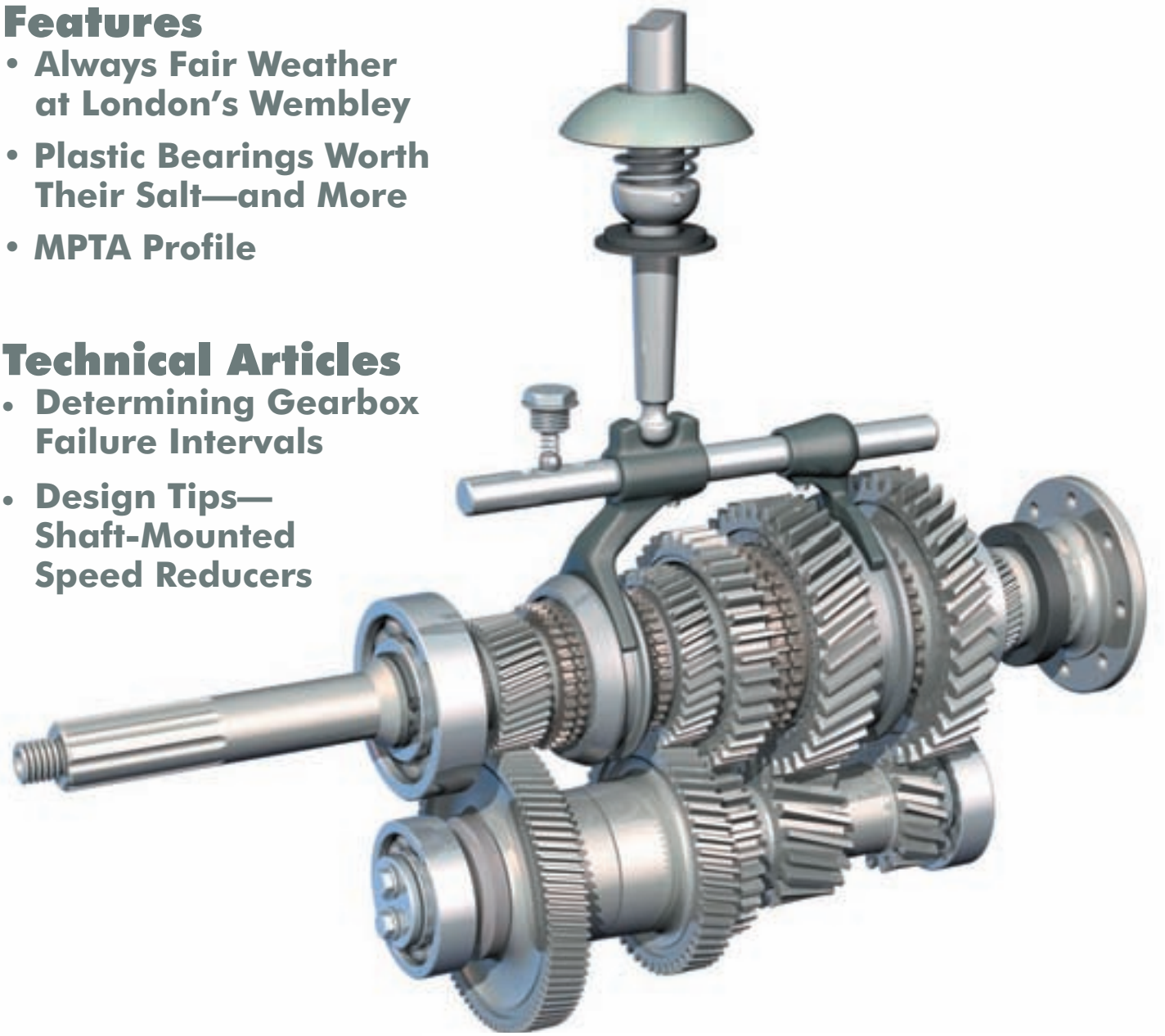
Features

- Always Fair Weather at London's Wembley
- Plastic Bearings Worth Their Salt—and More
- MPTA Profile

Technical Articles

- Determining Gearbox Failure Intervals
- Design Tips—Shaft-Mounted Speed Reducers



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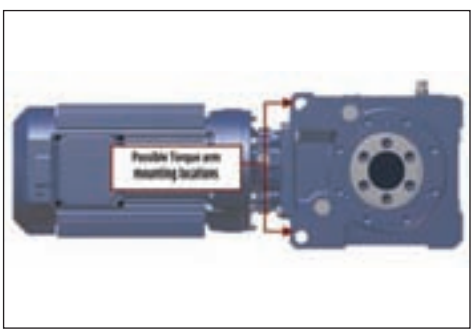

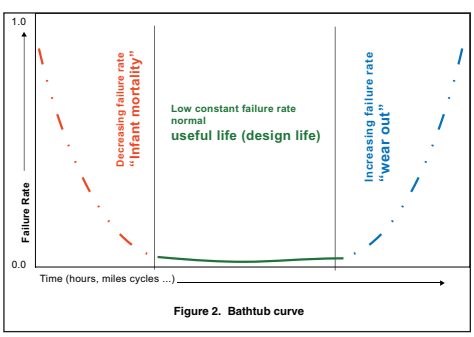

Figure 2. Bathtub curve

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DEPARTMENTS

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Large-Bore Shaft Collars

CUSTOMIZED FOR HEAVY-DUTY EQUIPMENT

Large-bore shaft collars new from Stafford are designed for paper converting, timber processing, mining, drilling and construction equipment, in addition to any other oversize material handling systems. Stafford customizes these large-bore shaft collars by material, size, configuration and quantity, making them versatile for various customer requirements. Stafford offers smooth or threaded bores up to 16 inches outside diameter, and the widths vary from ½ inch up to 20 inches. The bores are made from steel, stainless steel, brass or bronze, and they are offered in one- or two-piece styles. Particular contours and tapped holes on the face or outside diameter are other modifications. The collars come with one or more alloy socket cap screws that are supplied in various sizes and quantities for favorable clamping power.

For more information:

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

MC4U Modular Control System

INTEGRATES COMPONENT PARTS

The MC4U modular control system from ACS Motion Control is intended for multi-axis motion control applications that need high performance, flexible drive configuration, PLC motion and logic control. The new product has eight integral servo drives and 64 distributed axes via CANopen, combining controllers, drives, power supplies and added I/O and networking capability, so machine automation functions, such as motion, logic, power and data, are all controlled by the MC4U control system. The panel or rack-mounted system focuses on each multi-axis motion control need, so development cycle time is reduced along with risk and costs.

The MC4U's intended use is for production, test and inspection

equipment that uses flat panel displays, semiconductors, electronic assembly, general automation or medical applications, and the system speaks to the motion and machine control needs of OEMs, according to the company's press release.

Since the MC4U includes motion controllers, cost is lowered because the need for individual controllers for each axis is removed. The host computer isn't required to handle the network because there is a single control module instead of several. The system is produced from off-the-shelf components, making assembly and delivery time shorter, so customers receive the product soon after they order—one to two weeks for fast prototypes or low-volume orders. This component feature also lowers maintenance costs because individual parts can be repaired without the need to replace the entire system.

For more information:

ACS Motion Control Ltd.
Ramat Gabriel Industrial Park
P.O. Box 5668
Migdal Ha-Emek 10500
Israel
Phone: 972-4-6546440
Fax: 972-4-654-6443
www.acsmotioncontrol.com

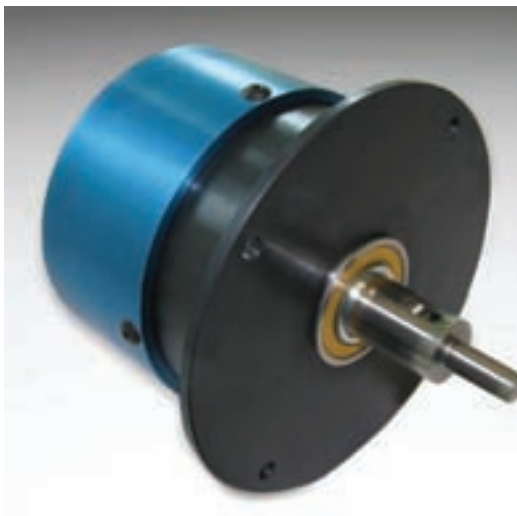
Torque Feedback Device

SIMULATES HYDRAULIC POSITION/VELOCITY FEEDBACK

Danaher Motion's Torque Feedback Device (TFD) meshes tactile and position or velocity feedback with a steering wheel interface in an IP66 rated package. The TFD provides electronic vehicle system, personal mobility and mobile off-highway machine builders the ability to create vehicles and machines capable of delivering the performance and maintenance benefits found in electric or steer-by-wire systems with the tactile response of a hydraulic system, according to the company's press release.

Since the product's design integrates major components, the result is a more compact, modular device capable of high torque densities and energy efficiency in use, as well as making the device easy to scale to specific application requirements. The TFD comes in five versions that range in torque densities from 2.5 Nm to 20 Nm, available as a stand-alone or integrated vehicle system component. When tested, their life lasted over 10,000,000 revolutions at 120 rpm, and they are designed to function in ambient temperatures from -35 degrees Celsius to 60 degrees Celsius.

Redundant sensors are a feature that make shaft feedback dependable and provide field serviceability. Friction materials and an electromagnetic actuation system provide a variable torque output proportional to a DC input for steering and other by-wire applications. Typical steer-by-wire applications include electric vehicles like lift trucks, golf carts, pallet trucks, floor sweepers and cleaning equipment. Other steer-by-wire systems are found



in are turf and garden equipment, aerospace appliances, construction equipment and marine vehicles.

"The Torque Feedback Device provides input to a controller that commands the actuation mechanism in steering and other by-wire applications," says product manager Geoff Rondeau. "The device also provides continuously variable torque output to simulate the 'feel' that users of hydraulic systems are comfortable with, allowing operators to more easily adapt to an electric-steer or steer-by-wire vehicle system. With legacy electric steering systems, this functionality either didn't exist, was too complex or had to be developed and implemented by the vehicle manufacturer."

For more information:

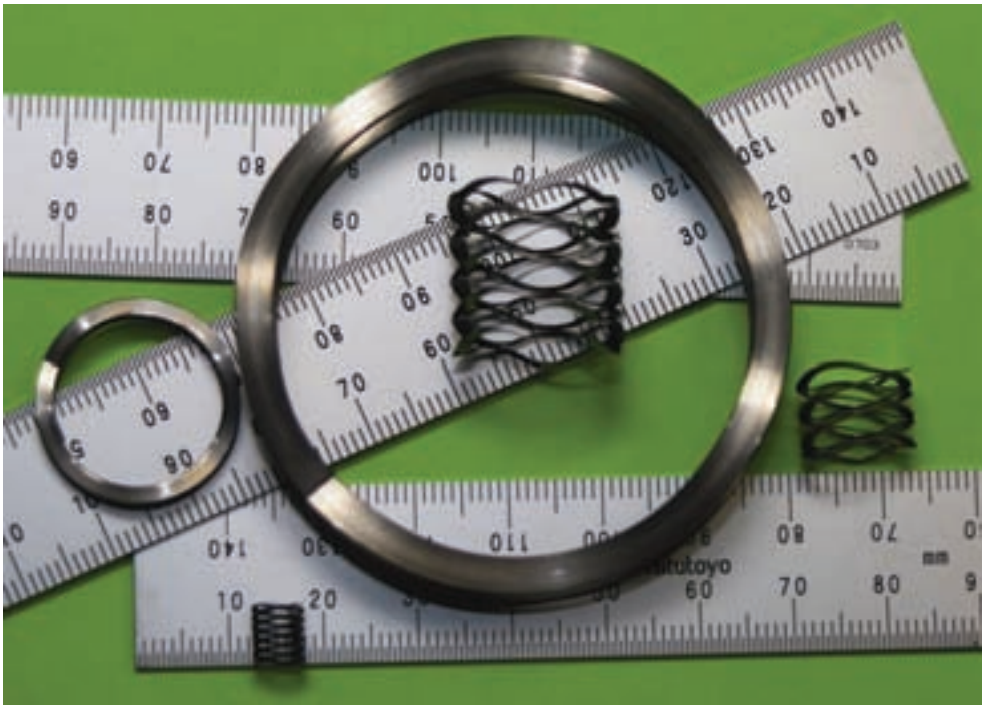
Danaher Motion
1500 Mittel Blvd.
Wood Dale, IL 60191
Phone: (866) 993-2624
Fax: (636) 281-1517
contactus@danahermotion.com
www.danahermotion.com

Smalley's Crest-to-Crest Springs

SLASH ASSEMBLY SIZES

Smalley's new series of metric Crest-to-Crest wave springs provide original equipment manufacturers with the ability to cut the size of their assemblies up to 50 percent with force and deflection comparable to regular coiled springs, according to the company's press release.

The spring cavity required is smaller, effectively reducing assembly size and cost. Smalley makes over 3,000 standard wave springs in 17-7 stainless steel or carbon steel. The Crest-to-Crest series comes in sizes from 6 to 60 mm. The company is providing free samples for anyone who sends an online request to them.



For more information:

Smalley Steel Ring Company
555 Oakwood Road
Lake Zurich, IL 60047
Phone: (847) 719-5900
Fax: (847) 719-5999
info@smalley.com

Active Cube

MAXIMIZES MACHINE AUTOMATION OPPORTUNITIES

The Active Cube (ACT3) series from Bonfiglioli is used to design automation solutions for industrial machinery and plants. It is appropriate for use as both a system drive and a servo drive because it fits the standards of most motion control applications. Users can rearrange drive routines because Active Cube's logic functions are integrated, and the drive is adapted to specific control needs. The ACT3 is highly compatible with the other drives in the system because data can be substituted and/or coordinated quickly. As far as servo applications go, Active Cube is compatible with other Bonfiglioli synchronous servomotors and other accessories, such as the BTD and BCR series. Users can potentially form a complete Bonfiglioli servo system, so they can ensure each component will work well together. Technical support is important in the Active Cube series with several devices for diagnostics and troubleshooting, according to the company's press release.

The ACT3 hardware features include a safe torque off function, external 24V DC supply, integrated dynamic braking module DC link connection, standard encoders interface, resolver module, motor temperature monitoring, and plug-in power and control terminals. The main software features include 32 programmable motion blocks, 36 homing functions, unit converter, jog function, absolute and relative positioning modes, touch probe, teach-in functions, rotary table control, reference value channel, motor potentiometer, PI controller, bumpless torque/speed changeover, index and stability control and functions for lift, crane and winch applications.

For more information:

Bonfiglioli Riduttori S.p.A.
Via Giovanni XXIII, 7/A
40012 Lippo di Calderara di Reno - Bologna
Italy
Phone: (+39) 0516473111
Fax: (+39) 0516473126
bonfiglioli@bonfiglioli.com
www.bonfiglioli.com

Warner Electric

IMPROVES CLUTCH/BRAKE MODULES IN NEW LINE

The Gen 2 packaged electromagnetic clutch/brake modules present several enhanced performance and appearance features compared to the original C-Face design. The internal component mounting and external housing fin design raise heat dissipation, so stop/start frequencies are more effective, and the input-to-output axis alignment reduces vibration, noise and wear. Using integrated custom mounting bolts for installation, the conduit box is located right on top of the unit, so orientation across the product line is more consistent. Optional cover kits are available that translate vented units into fully enclosed modules that keep contaminants out and wear particles in, so they operate cleanly and quietly, according to the company's press release.

The fit and wiring requirements of the unit remain the same, so they are compatible to replace C-Face models in sizes 50-180. For users transitioning from previous models to the Gen 2 line, the company has created tools such as a Gen 2 website (*www.warnerelectricgen2.com*), an interactive training program, a part conversion tool and an updated e-catalog to help phase in the conversion process.

For more information:

Warner Electric
449 Gardner Street
South Beloit, IL 61080
Phone: (800) 234-3369
www.warnerelectric.com

Pepperl+ Fuchs' Vision Sensors

SERVE MULTIPLE PURPOSES

The VOS300 series vision sensor from Pepperl+Fuchs integrates a camera, illuminations, digital outputs, process data and five evaluation methods into one sensor housing. The sensors can be configured without programming knowledge and controlled without detailed image processing experience. They are appropriate for use in applications that traditional photoelectric sensors are not suitable for, according to the company's press release.

There are two versions of the new sensor series available. The VOS301 can test a single feature of a target object, and the VOS310 can test as many as five different features. They perform like simple sensors with one output showing pass/fail status, and they have a 100 mm sensing range with internal illumination and a 500 mm range with external illumination. Objects within the 500 mm field of view, which is 135 mm x 100 mm, are detected regardless of orientation (rotation). The VOS300 vision sensors use VOS3-Config software, which is designed to be simpler by not using complex programming language.

"Complex inspections and error proofing applications have traditionally required expensive components that are difficult to install and use. With the VOS300, hardware and software are standardized in a fully-integrated package, eliminating the need for more complex systems and the integration of individual components," says Dr. Helge Hornis, manager of intelligent systems.

For more information:

Pepperl+Fuchs, Inc.
Factory Automation Division
1600 Enterprise Parkway
Twinsburg, OH 44087
Phone: (330) 486-0001
Fax: (330) 405-4710
sales@us.pepperl-fuchs.com
www.am.pepperl-fuchs.com

Low-Temp Black Chrome Plating

RESISTS CORROSION,

Misumi USA, Inc. now offers low-temp, black chrome plating on various motion components the company provides, including linear shafts, linear bushings, linear guides, and ball screws in addition to other hardware such as precision-class washers. The coating is made when an anti-corrosion black film forms on an alloyed surface through a chemical process, and then the film is deposited on Misumi products to prevent cracking and peeling. The material functions under extreme temperature, repeated flexing and friction conditions and can be used for optical applications where low light reflection is required, according to the company's press release

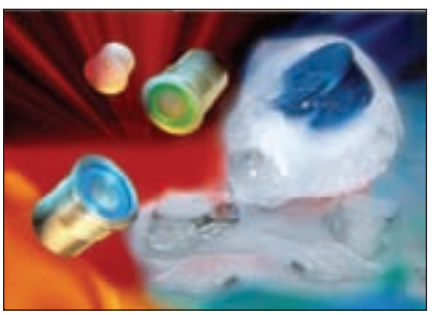
For more information:
Misumi USA, Inc.
1105 Remington Road, Ste. B
Schaumburg, IL 60173
Phone: (800) 681-7475
Fax: (800) 681-7402
inquire@misumiusa.com
www.misumiusa.com

diameters of 16, 19, 22, 24, 27 and 30 mm. For the 22 mm version, point or ring illumination is an option. Customized mounting diameters, materials, colors, shapes and laser lettering for the actuating surface are all available, according to the company's press release.

For more information:
Schurter Inc.
447 Aviation Boulevard
Santa Rosa, CA 95403
Phone: (707) 636-3000
Fax: (707) 636-3033
info@schurterinc.com
www.schurter.com

Schurter Piezo Switches

WITHSTAND EXTREME TEMPERATURES



With a newly extended operating temperature ranging from -40 degrees Celsius to +85 degrees Celsius, Schurter piezo switches are suitable for use in outdoor applications where intense temperature or temperature fluctuations take place, including ticketing and toll machines, call boxes, building access controls, construction equipment and transport vehicles.

The extended temperature switches are made with an anodized aluminum or stainless steel metal housing that is both durable and hermetically sealed. They feature a lifetime rated at more than 20 million switching cycles because the seal-tight surface design prevents material wear and mechanical fatigue; they resist dirt, sand, dust and water, and they don't freeze or stick through contact with fluids.

Schurter offers several mounting

Piezo Flexure Nanopositioning Stage Family

WIDENS TRAVEL RANGES

Physik Instrumente expanded the PIHera family of compact X, XY and Z flexure-guided piezo nanopositioning tables, so they are now capable of 50 to 1,800 µm travel ranges and less than 1 nm resolution. The PIHera stages work best for measuring and quality assurance applications; other applications they can be used for include scanning probe applications, biotechnology, nanometrology, interferometry, nanopositioning, semiconductor technology and static positioning, according to the company's press release.

A frictionless and stiff flexure system is responsible for compact size, quick response and guiding accuracy. Each stage has a non-contact capacitive sensor, which is an absolute-measuring, direct-metrology device that shows no periodic errors and has a high bandwidth. The flexures, actuators and sensors require no maintenance, and the PIHera stage family has closed-loop digital and analog control that makes positioning up to 99.98 percent accurate. PI offers vacuum compatible versions and low-noise controllers that have various software tool options, the company says in its press release.

For more information:

Physik Instrumente L.P.
16 Albert St.
Auburn, MA 01501
Phone: (508) 832-3456
Fax: (508) 832-0506
info@pi-usa.us
www.pi-usa.us

Compact Pneumatic Mini Slide

POSITIONS ACCURATELY

Festo Corporation's pneumatic mini slide DGSL features an integrated bearing system that is accurate to .01 mm and has linearity and parallelism in the 1/100 mm range, so the slide can be used as a pick-and-place system or for precise positioning.

The DGSL has an optional clamping unit and end-position interlock to avoid unwanted load drops onto workpiece carriers, which might occur with a compressed air supply breakdown, and protects against an emergency stop

scenario. A piggyback configuration can be arranged without adapter plates.

The DGSL comes in eight sizes ranging from four to 20 mm diameter with strokes up to 200 mm to encompass a variety of functions including those for the electronics industry, which requires tiny parts to be managed with great precision in potentially small areas. The mini slide offers flexibility with three end-stop systems—shock-absorber, cushioned metal stops and polymer stops.

For more information:

Festo Corporation
395 Moreland Road
P.O. Box 18023
Hauppauge, NY 11788
Phone: (631) 435-0800
Fax: (631) 231-9215
www.festo.com/usa

Sick Stegmann Encoders

EQUIPPED FOR DIRTY, DUSTY ENVIRONMENTS

These DFS 60 incremental encoders are made in a blind, hollow-shaft version, so the risk of potential contamination by dust, dirt or water is reduced. The hollow-shaft encoders are ideal for dirty and dusty conditions with water washdown cleansing. They offer resolution from 1 to 65,536 ppr and are suitable to perform in temperatures ranging from 20 to 100 degrees Celsius; these performance numbers are higher than those of typical optical encoders, according to the company's press release.

"Unlike most conventional optical encoders that have a glass or plastic rotating disc, DFS 60 encoders boast a unique nickel code disc that delivers significantly more robust and reliable operation than conventional encoders in heavy-duty industrial applications," says Scott Hewitt, president of Sick Stegmann, Inc.

For more information:

Sick Stegmann
7496 Webster Street
Dayton, OH 45414
Phone: (800) 811-9110
Fax: (937) 454-1955
sales@stegmann.com
www.stegmann.com

QTC Belt and Chain Tensioners

MAINTAIN CONSTANT TENSION

Quality Transmission Components has introduced a new line of belt and chain tensioners called the Zetasassi line that is designed to reduce noise, transmit torque more effectively, minimize wear and increase the belt and chain lives, according to the company's press release.

Tension can be modified on the chain or belt with spring-loaded Econobelt tensioners made in rotational and linear movement varieties; they are easy to install and require no maintenance. According to QTC's press release, the Zetasassi line of belt and chain tensioners result in a 23 percent increase in chain life, 7 percent reduction in vibrations, 12 percent reduction in noise and reduction in chain slackening.

For more information:

Quality Transmission Components,
Division of Designatronics, Inc.
125 Railroad Avenue
Garden City Park, NY 11040
Phone: (516) 437-6700
Fax: (516) 328-3343
www.econobelt.com/tensioners

Tsubaki Chain

WITHSTANDS HIGHER TEMPERATURES

A new product in Tsubaki's Lambda chain family, the H.T. Lambda, is heat resistant, operating at temperatures between 150 degrees Celsius to 230 degrees Celsius, displaying no degradation at high temperatures and featuring an extended wear life, enabling the chain for use in heat sealing packaging, semiconductor production, dry and steel furnaces and die casting for automotive parts, according to the company's press release.

The H.T. Lambda is designed for high-temperature operations that otherwise employ standard chains with special coatings, which are expensive, larger than usual, wear quickly and expend more energy while conveying equivalent power to the H.T. Lambda. The chain does not require added lubrication because it is built with oil-impregnated bushes, offering steady, food-grade lubrication that continues to function at high temperatures.

Tsubaki refers to the Lambda chain family as eco-friendly because they are evaluated with a life cycle assessment (LCA), which measures the environmental aspects of the chains from raw materials to waste management, and they demonstrate a CO_2 reduction of 89.4 percent, according to the Tsubaki press release.

For more information:

1-1-3 Kannabidai
Kyoto 610-0380
Japan
Phone: +(81) 774-64-5023
Fax: +(81) 774-64-5212
http://tsubakimoto.com

Aerotech Linear Stage

TRAVELS UP TO 600 MM

Aerotech's linear stage, the ATS165, is used for applications that require debris protection and mid-tier positioning performance. In addition to other models' features, the ATS165 has added load carrying capability with larger bearings and a wider cross-section.

Durable construction features debris protection and a scratch-resistant surface while minimizing contamination with side seals that are arranged vertically to avert debris. A brush assembly is available for the tabletop to eliminate particles that might build up on the hard cover. The ATS165 is equipped with

a NEMA 23 motor flange mounting interface and can be purchased with or without a motor, providing customers with the option of using an alternative, third-party motor. The stage has a ground 5 mm/rev. ball screw with a 0.5 µm resolution, according to the company's press release.

For more information:

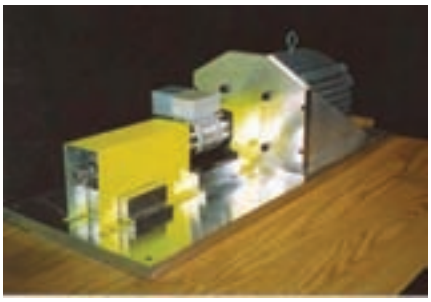
Aerotech, Inc.
101 Zeta Drive
Pittsburgh, PA 15238-2897
Phone: (412) 963-7470
Fax: (412) 963-7459
sales@aerotech.com
www.aerotech.com

Dynamometer System Family

COMPATIBLE WITH VARIOUS TESTING APPLICATIONS

Sakor Technologies presents a new AC motoring dynamometer family, the Accudyne, which provides a dynamometer system compatible with a range of testing applications, including conventional engine and powertrain systems, hybrid vehicle drives, electric motors and rotary components, such as alternators, generators, pumps, compressors and more.

The Accudyne sizes are varied, stretching from fractional to more than 2,000 horsepower with speeds greater than 30,000 rpm, so they can be used for most rotational testing needs. With stall capability for low-speed applications



that require full torque, the system also has 4-quadrant potential and can cross over between motoring and loading modes.

For more information:

Sakor Technologies, Inc.
2855 W. Jolly Road
Okemos, MI 48864
Phone: (517) 332-7256
Fax: (517) 332-7250
info@sakor.com
www.sakor.com

Saltwater Solutions From igus

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Lindsey Snyder, Assistant Editor

igus iglide T500 bearings' high compressive strength appealed to Island Engineering.

Each T-foil Island Engineering produces has 46 iglide T500 bearings.

Aquatic engineering applications take on a whole different world of physics that members of the marine vehicle industry face with each new product they develop. Companies like Island Engineering, located in Piney Point, Maryland and General Boats, based in Edenton, North Carolina, uncovered a valuable solution to circumvent the corrosive effects saltwater has on machinery by using igus plastic bearings.

"Igus bearings are ideal for water, especially saltwater, applications because they're all made of non-corrosive, high-performance plastics," says Courtney Toomey, marketing specialist for igus.

Island Engineering focuses their attention on engineering technology for advanced marine vehicles, including their vessel motion control system—Spectrum. Other company projects include a high-speed catamaran, small waterplane area twin-hull (SWATH), monohull and wave-piercing catamaran.

The marine engineering technology company used igus iglide T500 bearings with three interrelated products: T-foils, ActiveSkegs and interceptors. The T-foil is a system application that stabilizes a boat's motion using pivoting titanium flaps that are controlled by a fly-by-wire computer system. The system is ideal for fast-moving boats capable of speeds up to 50 knots. The interceptors communicate positioning information to the flaps, so a marine vehicle can counteract the normal action from waves that is primarily responsible for symptoms of seasickness passengers might experience. The ActiveSkeg is a fin designed to hold a vessel more steadily on course, reducing the extent it may stray off course from +/- 20 degrees to +/- 2 degrees.

The iglide T500 plain bearings from igus are engineered to withstand UV rays, severe chemicals and corrosive substances, like saltwater. They are made from all-polymer material—as is each member of the iglide bearing family—so there is no lubrication or maintenance needed, and they absorb minimal moisture, enabling them to perform in continuous submersion. The T500 bearings have a high compressive strength that appealed to Island Engineering. Where high radial pressures are a factor, the T500 bearings last twice as long as coated or lubricated metallic bearings, according to igus.

"T500 is what I would call a problem-solving bearing," says Rick Loheed, director of engineering for Island Engineering.

"We have been impressed with its performance and with the service provided by igus and its sales force."

Each T-foil Island Engineering produces is made with 46 iglide T500 bearings, according to igus in a press release. The bearings are available off-the-shelf, so they can be delivered overnight if any failure ever occurred, minimizing downtime and money spent on maintenance. They are ideally used for outdoor and marine equipment, in addition to power transmission, semi-conductor, textile and high heat equipment—such as ovens.

General Boats—Sailing Anyone?

In 2004 igus welcomed submissions for a unique plastic bearings competition devised to promote the benefits plastic bearings have over metal ones. While highlighting significant technological advancements made in recent years that resulted in more widespread application of plastic bearings, the manus competition drew attention to the diverse usage and cost-efficiency of plastic bearings. Several industry experts judged the competition and awarded winners during National Manufacturing Week 2004.

"The manus contest seeks original applications using plastic bearings in creative and ingenious ways to obtain technical and economic efficiency. Manus represents courage and initiative in advancing bearing technology," igus stated in an informational pamphlet describing the competition.

General Boats, a manus contestant, used iglide bearings for their signature marine vehicle. The Rhodes 22 sailboat is a trailerable, cruising vessel with several unique components made possible by the iglide J bearings.

The iglide J is designed for high-speed and low-speed applications, operating up to 1.968 feet per minute (fpm) in linear motion and 197 fpm in rotary motion, according to igus in a press release. It can be a less expensive alternative to metal-backed and custom injection-molded bearings available in sleeve, flange and thrust-washer configurations.

The Rhodes 22 is equipped with a mechanism developed by General Boats that is capable of lifting an outboard motor in vertical movements, so boat drivers can operate the device and monitor potentially heavy bow traffic simultaneously. The company gravitated towards the iglide J bearings because of their low cost, ability to rotate effectively when the offset motor applied heavy torque pressure, and they produced no noise, unlike other bearing solutions considered.

The Rhodes 22 is also fitted with an innovative inner mast furling system (IMF), a typically high-cost feature for large sailboats. A boat's sail is rolled in the mast in order to release or pull in the sail depending on wind conditions. General Boats faced a problem with this technique because the forces involved resulted in significant jams that required extensive lubrication. When the pressure involved in pulling out the sail is applied to the iglide J bearings instead of on the rotating tube responsible for rolling the sail in or out, the result is a system devoid of locking action.

"The system works flawlessly and with a bonus feature," said Stan Spitzer, owner of General Boats. "As far as we can see, no maintenance is ever needed. Our IMF main sail furling system is the major reason why buyers choose a Rhodes 22 over the competition."

The iglide J bearings are used in the DryLin R linear bearings and other linear slides; they are a signature product from igus. Many other customer applications are posted on the igus website in a section the company calls the "Application Corner." Interested customers can read about unique engineering designs from industries as far ranging as packaging, medical and agricultural, and clients can post their own stories there as well.

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The Rhodes 22 is equipped with a mechanism that lifts an outboard motor in vertical movements.

General Boats' inner mast furling system works flawlessly using igus iglide J bearings.

Rain or Shine

BREVINI POWER TRANSMISSION HELPS SPECTATORS ENJOY STADIUM'S SIGHTS & SOUNDS

Matthew Jaster, Associate Editor

More than 90,000 spectators will watch the English national football team at Wembley Stadium in London without knowledge of the engineering magic occurring high above the field of play. Wembley, the world's largest covered stadium, boasts a retractable roof newsworthy simply for its daunting size and scope.

While retractable roofs are nothing new to sports fans, Wembley is an unusual case due to the amount of materials and equipment involved in the makeup and design. Brevini Power Transmission, a global producer of planetary gears and mechanical transmissions, is one of many companies that contributed to the project.

The 7,000 ton roof is partly retractable, exposing Wembley's famous turf to direct sunlight and ventilation. It can be moved up to the touchline on the field, ensuring every fan is sheltered from inclement weather during events. With the roof open, the sun reaches all corners of the field. The architects even employed astronomers to calculate the sun's position on May afternoons so that at three o'clock on the final day of the FA Cup only the two southern corner flags are in shadow, according to the Wembley Stadium website. (A small, albeit important, step to ensure television cameras don't have to deal with heavy shadows during matches.)

Retractable roofs have been considered achievements in architecture since the Skydome first opened in Toronto in 1989. The Skydome (currently known as the Rogers Centre) was the first stadium to boast a fully retractable roof. It consists of four sections that close or open in 20 minutes. Since opening, the Skydome has been used as a model for similar stadium projects around the globe.

None of these projects, however, has compared to the task of creating the retractable roof for Wembley. Dennis Van Arkel, sales manager of Brevini Benelux, a subsidiary of Brevini Power Transmission, says the technical support from the very beginning of the project made the job easier for Brevini.

The fixed part of the stadium roof is attached to one side of an imposing metallic arch that weighs 1,750 tons, is 133 meters tall and has a span of 315 meters. The arch supports more than 60 percent of the roof's weight. On the other side of the roof are seven sliding panels that can open and close to protect the spectators or eliminate shadows.

Hollandia-Bailey Technogroup, working with Brevini Power Transmission, supplied the rack and pinion system for the project, much like they did for the Ajax Arena in Amsterdam and the Veltins Arena in Gelsenkirchen, Germany.

"The one-piece segments of the roof at Wembley were much bigger than what's been done with other stadiums," Van Arkel says. "To keep such huge weights under control, you have to build in several safety levels taking into consideration wind, snow, ice, rain, etc."

Thirty-four Brevini planetary gear units help the panels above Wembley Stadium slide perfectly into place. These panels move at a speed of 30 mm per second, and come in different sizes and

shapes with weights ranging from 63 to 330 tons. They move on roof trusses 160 meters long, opening and closing the roof in just 15 minutes.

Van Arkel says the experience Brevini has had with these applications since 1993 is the reason their gear units were chosen for Wembley.

"The Brevini units delivered for Ajax Arena have been reused without any review since the electrical system has been renewed," Van Arkel says. "The gearboxes have been working for nearly 15 years without any problem, and they'll run for another 15 years for sure."

In addition to the rack and pinion system, Brevini customized a transparent Perspex cover that protects the units from harsh weather conditions. This was a special request from the main contractors at Wembley.

"We're always proud to be involved in the kind of project that shows our capability and the trust big companies have with Brevini Power Transmission," he says.

The president and founder of Brevini Power Transmission, Renato Brevini, says Wembley signifies the level of cooperation Brevini has with their clients.

"We serve our clients through an international network of 24 subsidiaries that are able to design projects and customized parts. This approach ensures customer satisfaction in every phase of Brevini's relationship with the market."

The company is currently involved in several other projects, including the steering system for the Queen Elizabeth Cruise Liner and a special boat lifting system in Dubai with partner Bosch Rexroth.

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MPTA

REMAINS A VIABLE RESOURCE FOR POWER TRANSMISSION INDUSTRY

Jack McGuinn, Senior Editor

(*Following is another installment in* Power Transmission Engineering's (PTE) *ongoing series profiling trade groups and associations central to the power transmission and fluid power industries.*)

The Mechanical Power Transmission Association (MPTA) was founded in 1933 as the Multiple V-Belt Drive and Mechanical Power Transmission Association, adopting its current name in 1961. The group dedicates its efforts to the promotion, growth and continuous improvement of industry products such as sprockets, pulleys and other drivetrain-related components. Based in Naples, Florida and approaching its 75th anniversary, the association was one of the first to develop power transmission standards programs for the industry. As such, they continue today to be deeply involved in setting industry technical standards and publishing technical manuals and other valuable information.

Bob Renfried

As with most industry associations, the opportunity for networking and the give-and-take of ideas and observations is central to the MPTA's existence.

Bob Renfried, MPTA executive director, says "It's getting to know their industry peers" that is important. "I've heard many times how they (company members) encounter a problem at some point, and because they know individuals personally (through MPTA), they can call and ask them, 'Have you guys encountered this?' because of the relationship. It's accepted, where it might not be the case if it were a competitor they don't know personally."

It is that kind of back-and-forth that makes membership in MPTA essential, according to Renfried.

"It means so much more when a peer or (friendly) competitor of theirs calls and says 'Look, this is what we're gaining out of this association, or 'We're working on this,' etc."

But perhaps the central reason for MPTA membership is the ability of its member companies to be closely involved with the development and ongoing tracking of industry standards relative to power transmission applications involving sprockets, pulleys, etc.

"Standards are reviewed at every meeting," Renfried says. "We use what ANSI does in requiring our standards to be reviewed or reaffirmed at least every five years. A new standard will begin with a draft from a committee or member company representative. Drafts will be reviewed at meetings or, in some cases, via conference calls. We use the consensus method to approve the draft."

Renfried points out that—given their need for each other—the MPTA also works closely with the Rubber Manufacturers of America (RMA) in establishing standards, or at least for applications involving drive belts, for example. And while the MPTA publishes its standards free of charge on their website, those developed in conjunction with the RMA are for sale with the proceeds going entirely to the latter.

Cooperation with the RMA also extends to the MPTA's two annual conferences in the spring and fall. A technical representative from RMA attends in order to bring members up to date on any standards developed jointly. (In addition, "special association meetings" may be scheduled at any time by a majority vote of the board of directors.)

The conferences present members with the opportunity to discuss new products, technology and annual forecasts, among other things.

"Another major benefit of membership would be the collection and dissemination of sales statistics," says Renfried. Each member company reports monthly sales to the MPTA and participants receive aggregate totals. (In addition), the MPTA is currently working on adding chains and sprockets to the existing elastomeric couplings and belt drives reports that are now available.

Also of benefit to member companies is the association's monthly statistics program, as well other periodic surveys, all of which serve to closely track sales,

Power Up!

If you have a background in gears, bearings, motors, belts, couplings, sensors or actuators, we'd like to talk to you. Powerplay, the new back page feature in *PTE*, is all about your industry. If you've got a funny anecdote, an interesting observation or perhaps a limerick on motion control, feel free to send it our way. This column is dedicated to the stories too radical to make the cut in industry or product news. We need story ideas, and we're confident you can provide them.

The rules are quite simple: submit a story idea about the power transmission industry, make it entertaining as well as informative, and become a *PTE* magazine editor-at-large today (salary not included). Submit your award-winning material to *publisher@powertransmission.com.*

trends and other factors central to the mechanical power transmission industry. It is, however, a you cannot-win-if-you-do-not-play scenario. Only member companies that supply sales data and respond to MPTA surveys are entitled to receive the published results.

Beyond that, Renfried lists the essential reasons for the MPTA's creation:

- To promote the manufacture and sale of mechanical power-transmission equipment and increase public interest in such equipment.
- To encourage constant improvement in standards of manufacturing and engineering practice.
- To serve its members in matters of common interest and to appear for its members and for the industry before legislative committees, government bureaus and other bodies in regard to matters affecting the industry.

The basic requirement for joining the MPTA is that a company be "actively and substantially" involved within North America in the "design, manufacture and sale" of mechanical power transmission equipment for at least one year prior to applying for membership. Officers include a president, vice president, secretary, treasurer and executive director. All officers are chosen primarily from the active membership and serve without compensation, although some are recruited from the outside at an agreed upon salary.

In order to blanket its targeted industries, the MPTA is divided into three member company categories—belt drive and pulley; elastomeric coupling; and chain and sprocket. A partial list of the MPTA's 24 member companies follows:

- Belt Drive and Pulley
  B&B Manufacturing; Baldor Dodge Reliance; Carlisle Power Transmission Products; and Emerson Power.
- Elastomeric Coupling:
  Frontline Industries, Inc.; Lovejoy, Inc.; Magnaloy Coupling Co.; and Martin Sprocket and Gear, Inc.
- Chain and Sprocket: Diamond Chain Co.; Drives, Inc.; U.S. Tsubaki, Inc.; and Webster Industries.

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FOREST CITY GEAR

Torque Arm Design Considerations for Shaft-Mounted Speed Reducers

Todd R. Bobak *has worked in the gear industry for 15 years. He has held positions in technical service, design and development, and quality assurance. He is a product engineer for Sumitomo Drive Technologies in Chesapeake, VA.*

Todd R. Bobak

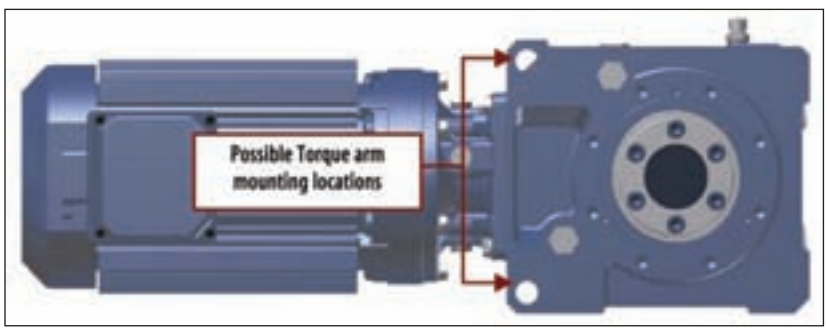


Figure 1—Manufacturers often provide multiple mounting holes for the placement of a torque arm, as seen in this picture of a Sumitomo Cyclo Bevel Buddybox.

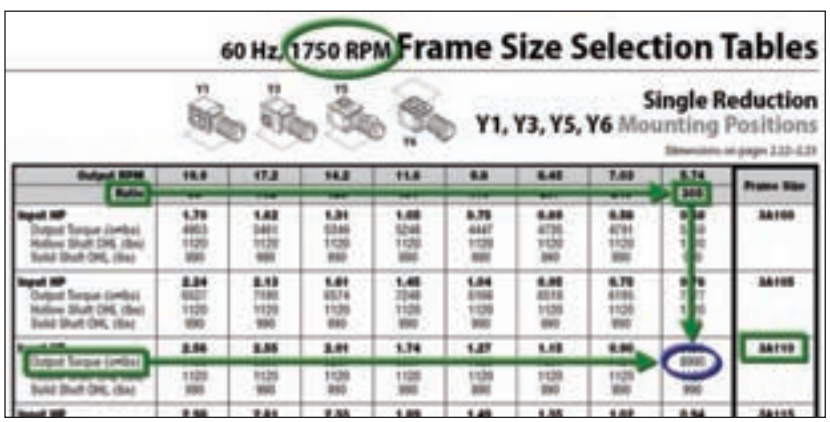


Figure 2—Output torque capacity can be determined from a manufacturer's spec sheet based on the model's motor input speed rpm and gear reduction ratio.

Introduction

In the power transmission industry, shaft-mounted speed reducers provide one possible solution to meet the speed reduction/power generation needs for an application. As the name implies, a shaft-mounted speed reducer (SMSR) is a speed reducer mounted directly onto, and statically supported by, a driven shaft—the type of setup that may be found on a conveyor. Typically, the SMSR incorporates a hollow bore (with keyway, tapered bushing or some other coupling mechanism) to facilitate mounting onto the driven shaft.

The SMSR may be "fixed" to the machine using an output flange or, in certain instances, its housing may be bolted directly onto the machine. However, situations exist where direct attachment of the SMSR is either not possible or desirable. In such situations, the SMSR is supported only by the shaft that it is intended to drive. When the SMSR is mounted directly onto a driven shaft with no other external support, it must have a torque arm attached to it. A torque arm is a pivoted, connecting link between the reducer and a fixed anchor point intended to resist the torque developed by the reducer. Quite simply, a torque arm transmits the reaction torque produced by the SMSR

into the structure of the machine, thereby preventing the counter-rotation of an SMSR during operation. Most manufacturers of shaft-mounted speed reducers have designed, and offer for purchase, standard torque arms for their products. Situations may exist, however, where a manufacturer's torque arm does not meet the needs of a certain application (due to space limitations, for example). In such situations, the machine designer may be required to design his or her own torque arm to fit within the constraints of the application. This article provides some design guidelines for such a situation.

Resultant Force

In considering the design of a torque arm, first you need to understand the amount of load (or force) that the torque arm may see during unit operation. To determine this force, you need two pieces of critical information:

1. The torque capacity of the SMSR. As the name implies, this is the mechanical capacity (typically expressed in terms of inch-pounds or Newton-meters) that the SMSR is capable of developing at its output. While it may be tempting to simply multiply the motor output torque by the reducer's reduction ratio to obtain an output torque value, it is recommended to consider (at a minimum) the larger of the following values: the SMSR's output torque capacity (as listed in the product catalog) or, the product of the motor's output torque and reduction ratio times an additional 2.5—to take into account the motor's starting torque.

2. The dimensional location on the SMSR where the torque arm will be mounted. Manufacturers of shaft-mounted speed reducers provide at least one mounting location for a torque arm (Fig. 1). Note that the point where the torque arm attaches to the reducer (either directly or indirectly through a bracket) is known as the pivot point. Many manufacturers provide more than one potential location for the torque arm in order to accommodate the various mounting configurations available for a given product. The location(s) of these mounting holes/positions may be found in catalog cut sheets or through manufacturer-supplied product drawings.

Using Figure 1 as an example, let's say an application requires a bracket-style torque arm, and this bracket will be attached to the housing at both identified mounting holes. Using the unit model size, reduction ratio, and motor input speed, you can determine the output torque capacity from the reducer catalog ratings table (Fig. 2).

You can also use the catalog dimension sheet to determine the location of the identified mounting holes relative to the center of the reducer's output bore (Fig. 3).

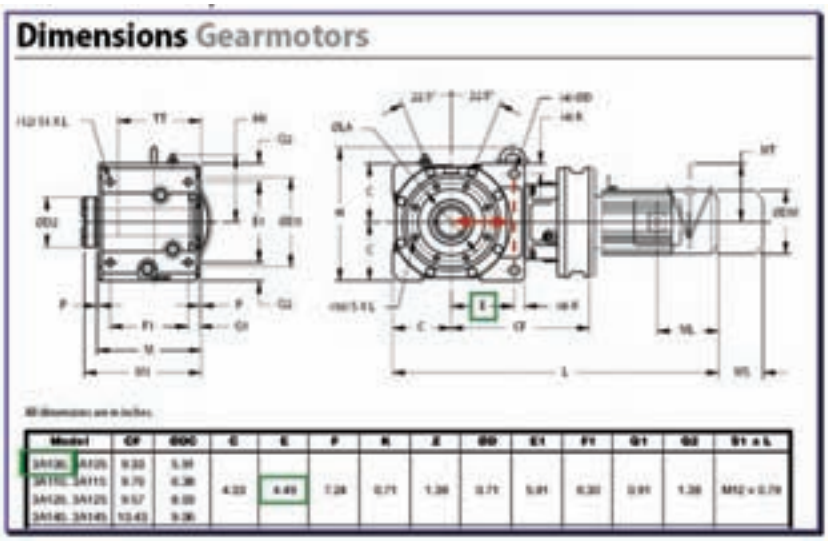


Figure 3—Manufacturer's specifications will also reveal the exact location of the mounting holes relative to the center of the reducer's output bore.

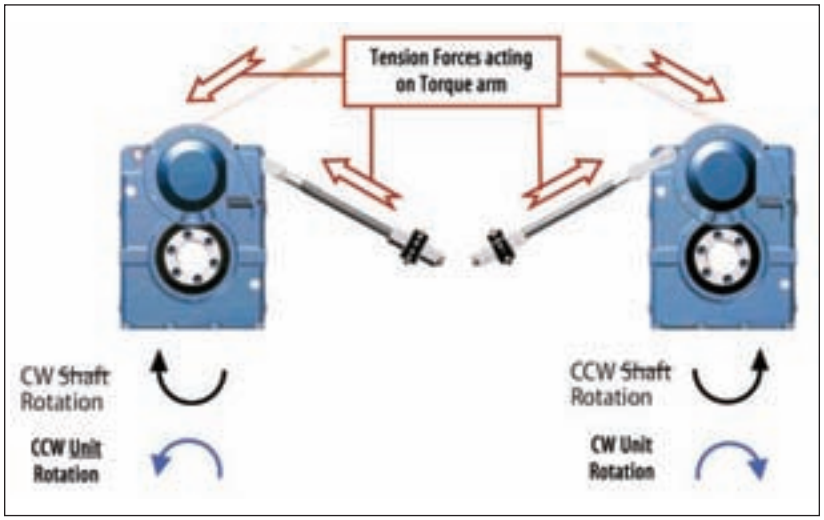


Figure 4a—In order to maintain pure tension loading for the torque arm, the pivot point of the torque arm should run along, or parallel to, the line of action. The line of action (see figure 4b) is defined as the right angle formed by a line joining the pivot point and the center of the SMSR's output bore.

With this information, you can now calculate the force acting at the selected pivot point, given the fact that torque is the product of force and distance. You can determine the unknown force (F) using these formulas:

Torque (T) = Force (F) • Distance (L), or
F=T/L (1)

It is important to note that during operation, the SMSR will tend to rotate about the driven shaft in the direction opposite to that of the driven shaft's rotation. With this in mind, it is significant that the calculated force F (above) acts in pure tension on the torque arm. This fact is especially important for torque arms that are long—if they are exposed to compressive forces, they may buckle. Figure 4a shows the correct

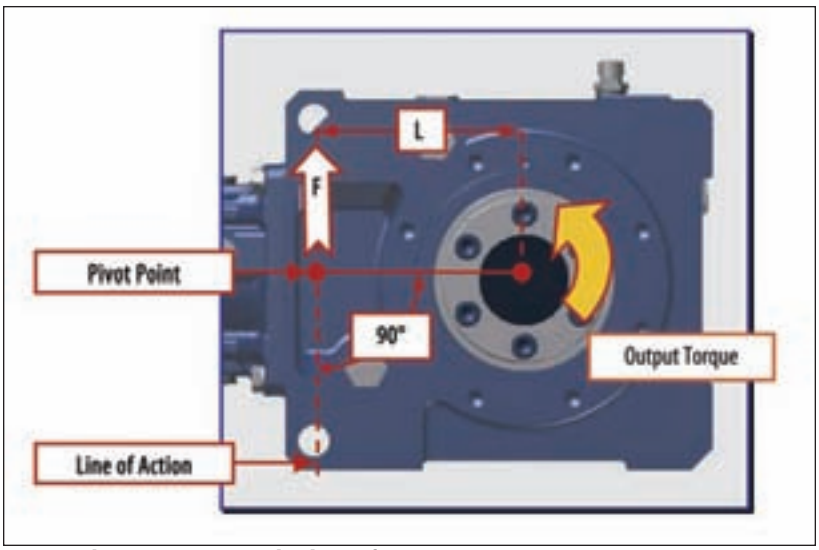


Figure 4b—Determining the line of action.

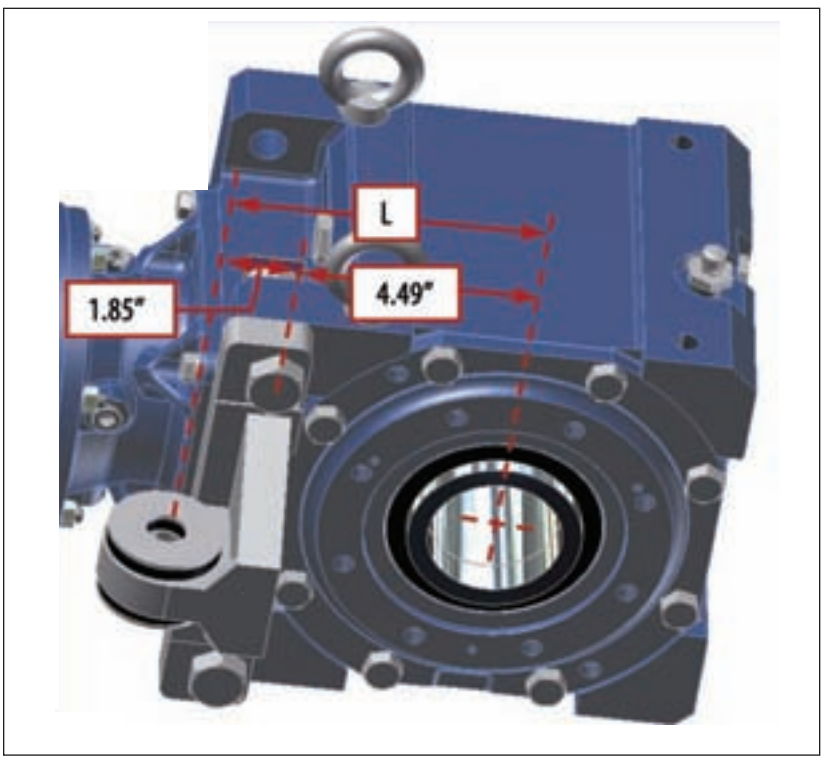


Figure 5—In this example, the reducer has a T-type torque arm mounted to it, which moves the pivot point an additional 1.85 inches farther from the center of the reducer's bore.

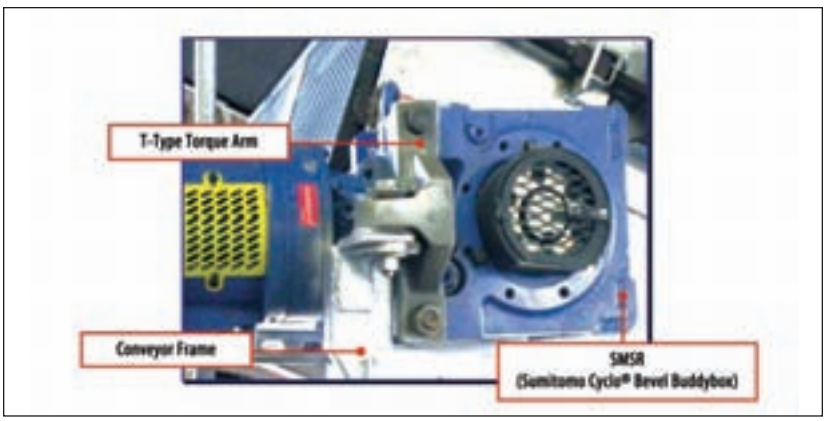


Figure 6—A shaft-mounted speed reducer in a conveyor application with a T-type torque arm.

method of mounting a torque arm so that it is in tension.

Using values from the manufacturer's specifications (Figures 2 and 3 for our example), you can calculate the resultant force acting at the pivot point as follows:

$$T = (F)(L)$$
$$F = T/L$$
$$= 8{,}990 \text{ in.-lbs.}/4.49 \text{ in.}$$
$$= 2{,}002 \text{ lbs.} \quad (2)$$

In essence, the connection method at the pivot point you chose (i.e., bolt, threaded rod, etc.) must be able to withstand this calculated force when in tension. If you find that the calculated force exceeds the physical limits of the connection method, you may choose to incorporate a different, stronger material for the torque arm.

A way to minimize this force is to increase the distance L of the pivot point, as shown in Figures 5 and 6. In these examples, the reducer has a T-type torque arm mounted to it, which moves the pivot point an additional 1.85 inches farther from the center of the reducer's bore.

If all other factors remain the same, this increase in distance yields a decrease of nearly 600 pounds in the force on the torque arm. Thus:

$$T = (F)(L)$$
$$F = T/L$$
$$= 8{,}990 \text{ in.-lbs.}/(4.49 + 1.85) \text{ in.}$$
$$= 1{,}417 \text{ lbs.} \quad (3)$$

Once again, this calculated force must be compared to the yield stress of the torque arm material to assure that the material limitations are not exceeded.

A Turnbuckle for a Torque Arm

Provided that it will fit within the design constraints of your application, you may opt to use a turnbuckle for a torque arm. A turnbuckle is a device commonly used to tighten a rod or rope. Its components include a sleeve with screwed connections of opposite hands (left and right) at each end. Upon turning the sleeve, the connected parts (threaded rods) will be drawn together, taking up slack and producing tension (Fig. 7).

You can calculate the force acting at the pivot point in this situation using the same formula for force as in the previous examples. Figures 8-9 show a typical mounting style for a turnbuckle torque arm.

A Note About Mounting Hardware

In addition to assuring that the forces acting on the torque arm itself do no exceed the limitations of the torque arm material, you must also consider the effects of the force on the mounting hardware (nuts, bolts, etc.).

When taking this into account, you must note that the force is not acting on the hardware in tension, but rather in shear. Depending on the location of such hardware, bending movements induced by the force may also be acting on the hardware.

Hardware manufacturers usually provide yield and shear limitations for their products. Once again, it is important to compare the calculated forces/stresses acting on the hardware against the published limiting values to assure that the critical points are not exceeded.

A Note About Reversing Rotation

In reversing applications, the output of the SMSR rotates in one direction for a period of time, and then reverses and rotates in the opposite direction for a period of time. This application type requires considering the compressive forces that the torque arm must also bear.

Recalling that, ideally, a torque arm is mounted so it is in tension, in a reversing application, the torque arm may see a period of time when it also receives compressive forces. Such compressive forces, if great enough, could buckle the torque arm. For such applications, designers may want to add a second torque arm on the opposite side of the SMSR. The second torque arm would take the tension forces generated by the reverse rotation while minimizing the compressive forces on the first torque arm.

Angles Other Than 90°

Although it is important to maintain a pivot point at 90° to the center of the SMSR output hub, it may not always be possible due to limitations in the machine onto which the SMSR will be mounted. This is not uncommon, and reducer manufacturers who supply turnbuckle torque arms with their SMSR units often note that the torque arm may be mounted with an angular variation, such as ±15°.

In such situations, the designer needs to evaluate the effects of the resultant forces acting on the torque arm. Figure 10 shows a torque arm mounted to an SMSR at some angle (θ) that is less than 90°.

Because the torque arm is not acting at a 90° angle to the output bore of the SMSR, there are two forces acting on it. The free-body diagram in Figure 11 details these forces.

The resultant forces (FT and FS) are the

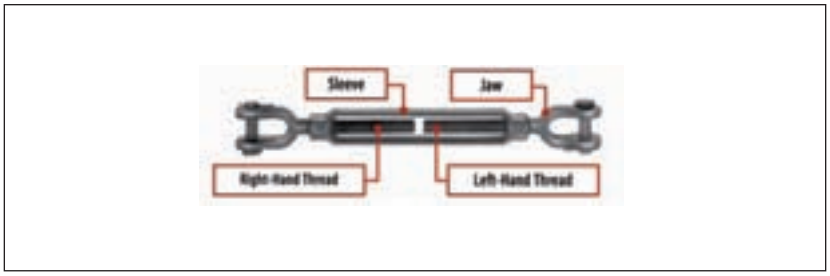


Figure 7—A typical turnbuckle.

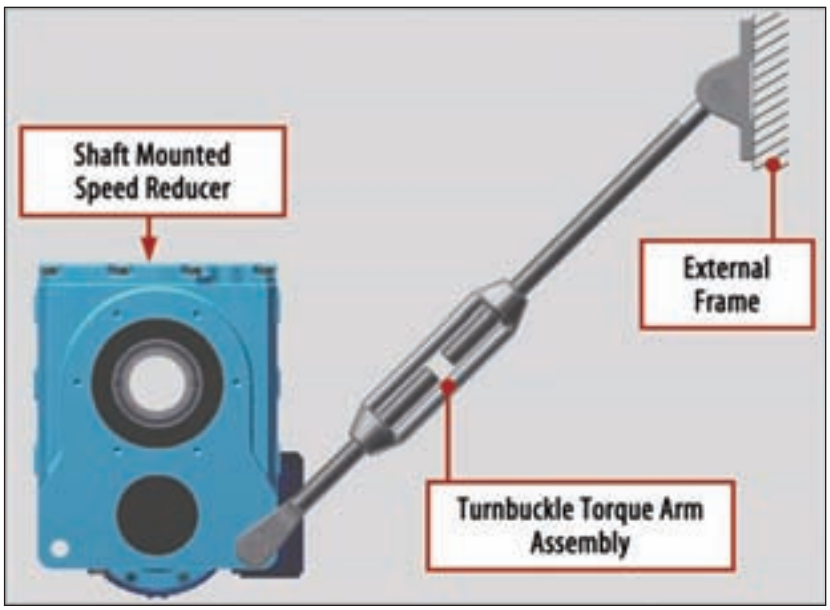


Figure 8—A typical mounting style for a turnbuckle-style torque arm.

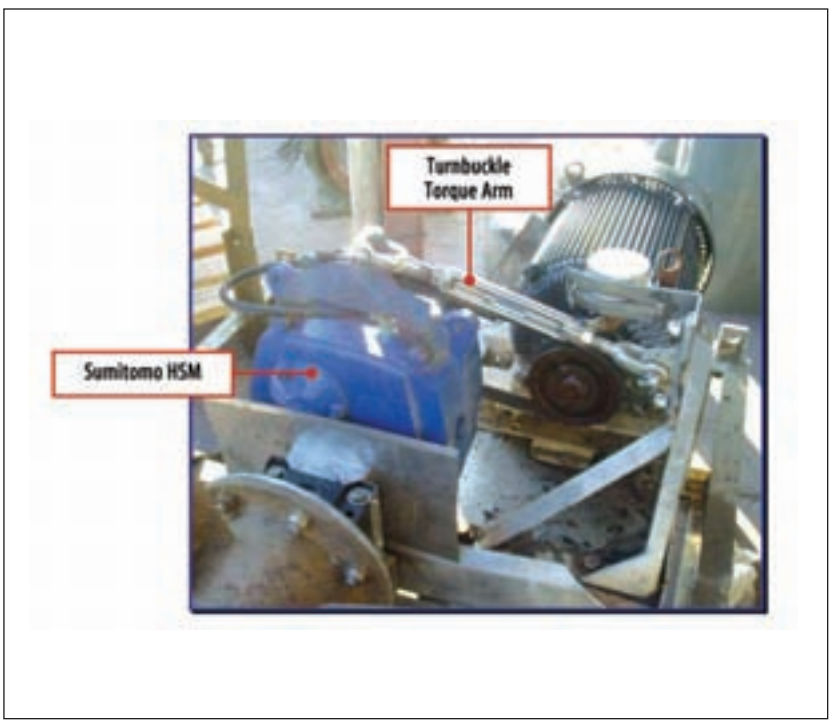


Figure 9—A turnbuckle-type torque arm being used on a Sumitomo helical shaft mount unit.

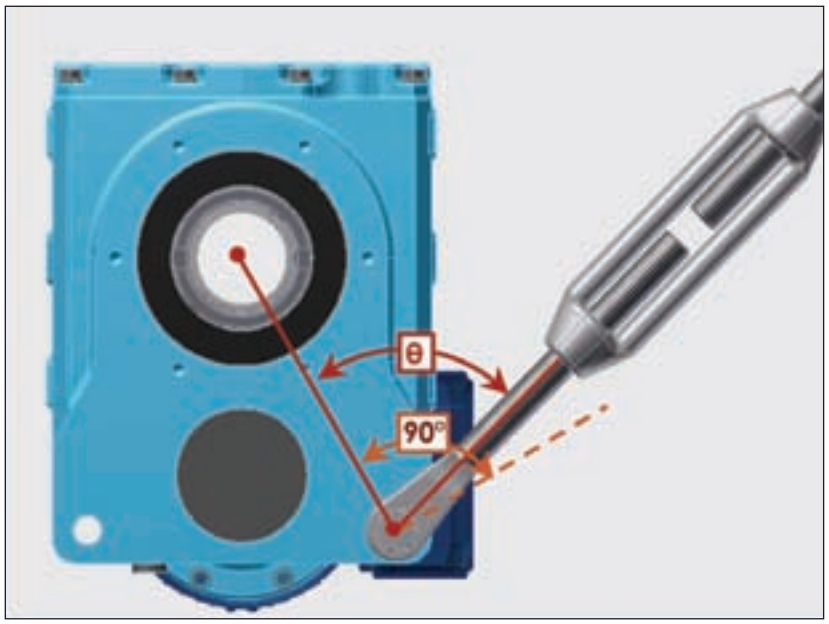


Figure 10—A torque arm mounted to an SMSR at less than 90°.

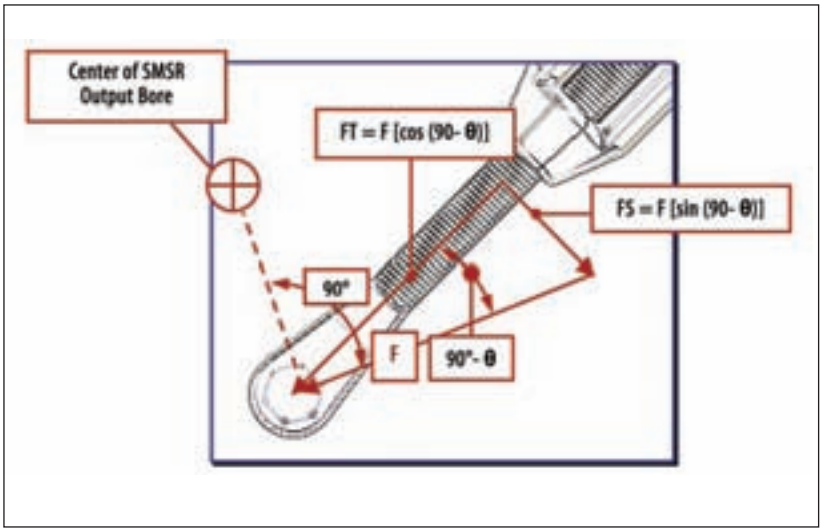


Figure 11—When a torque arm is mounted at an angle other than 90°, force F is composed of both tension (FT) and shear (FS) forces. Both must be considered when evaluating the strength of the torque arm design.

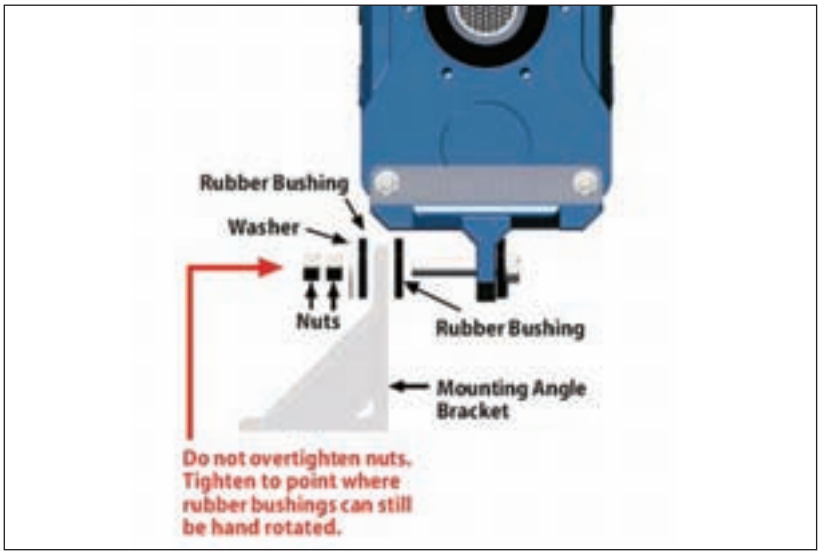


Figure 12—Rubber bushings installed at the anchor point and/or pivot point will provide "float" to compensate for runout in the driven shaft.

component forces of Force "F" acting on the torque arm. These resultant forces place not only a force in tension (FT) acting on the torque arm, but also a shear force (FS). Both forces must be considered when evaluating the strength of the torque arm design.

The Effect of Shaft Runout

Despite a high degree of accuracy in manufacturing processes, shaft runout sometimes occurs. Such runout (on the driven shaft) may cause the reducer to "wobble" on the shaft during operation. This could be particularly troublesome if the torque arm is rigidly mounted to the anchor point. A rigidly mounted torque arm attached to an SMSR driving a shaft with a high degree of runout may result in (among other things) a broken driven shaft, cracks at the anchor point, a decrease in the life of the output bearings of the SMSR and/or the conveyor and lubrication leakage. Introducing some "float" in the torque arm at the anchor point will counteract these problems.

Float may be introduced at the pivot point by attaching rubber bushings to the pivot and anchor points, as shown in Figure 12.

If dual rotation of the output shaft is possible in the application, manufacturers recommend installing rubber bushings on both sides of the pivot and anchor points so float is possible regardless of the direction of rotation.

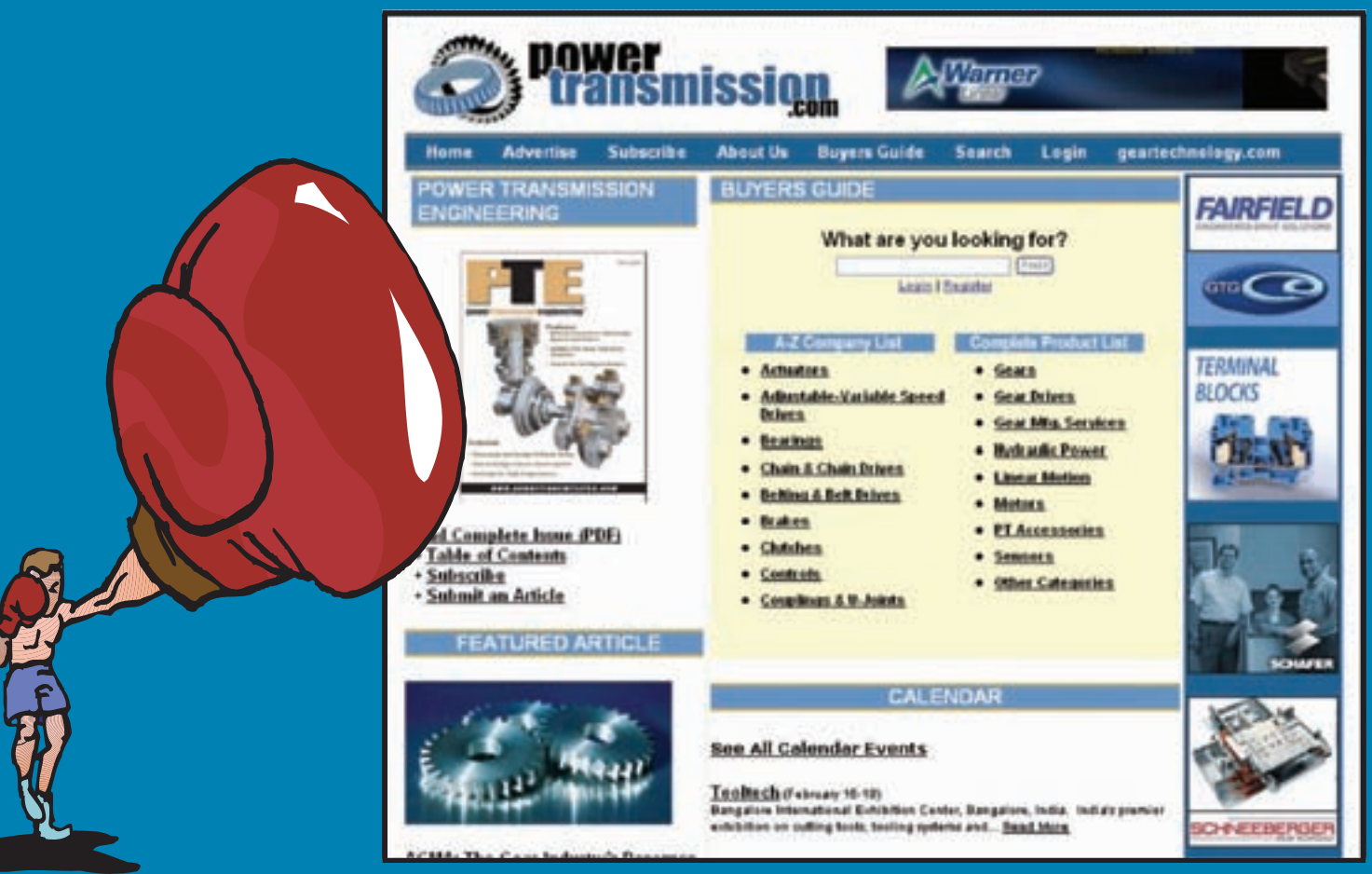
A loose clearance designed between the bolts and through holes in the torque arm bracket may also assist in creating float.

In addition to taking precautions to eliminate a rigid mount, designers must also ensure the torque arm is properly aligned when mounting it to the SMSR. Misalignment may inadvertently cause binding that could decrease or entirely eliminate this float.

Conclusion

Although seemingly simple in concept, a torque arm is an important component when considering a shaft-mounted speed reducer for an application. Before selecting a potential torque arm design, designers should evaluate the offering supplied by the manufacturer of the shaft-mounted speed reducer. In doing so, they may determine that the standard offering fits into the application constraints. Additionally, some manufacturers offer more than one standard design (i.e., turnbuckle, T-type) to meet a variety of applications. However, if the existing available designs fail to meet the established application criteria, following the methodology detailed in this article will help to develop a functional and robust torque arm design.

What Can Take 80,000 Hits and is Still Asking for More?



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How to Determine the MTBF of Gearboxes

Dr. Gerhard G. Antony

Dr. Gerhard G. Antony *possesses more than 30 years' experience in electro-mechanical and power transmission and automation. He earned his MS and PhD in engineering at the University RWTH-Aachen, Germany. After working at the university in education research and consulting, he went on to work in a wide range of positions and projects with and for companies such as SEW-Eurodrive, RACO International and Sumitomo PT. He currently serves as general manager of Neugart USA LP and is president/owner of the engineering firm i.MTRDC LLC. He has authored more than 25 papers in his field of concentration.*

Introduction

"Mean Time Between Failures" (MTBF) is a very frequent and broadly used reliability measure of components, systems and devices used mainly in conjunction with electrical and electronic equipment.

From the engineering perspective, assessing the life and reliability of products is a vital part of product design, development and selection. Life and reliability of a product are also important characteristics for the user (customer) in comparing gearboxes, for example, to assess their useful value or life for a certain application. The reliability of a product becomes a frequently used marketing and sales feature.

The life characteristics of different products and components depend on a wide range of factors—from type and condition of material used to type of exposure to loads, magnitude of the loads and other effects, such as environment. Products are designed for a certain purpose, function, duty, load, etc.; the life and reliability are of characteristic statistical value and thus can only be approached and assessed by statistical methods.

Today, an increasing number of manufacturers combine a mechanical device, such as a gearbox, with an electromechanical component such as an electric motor, and logic controllers and sensors into a compact, integrated "mechatronics" product. The MTBF value of many electronic components and systems is typically obtainable from the manufacturer. The design life of mechanical components and systems is mainly based on the endurance characteristics of the components relative to the statistical life expectancy under a certain load, such as the L10 design life standard. Can the reliability of a mechanical device such as a gearbox be expressed in terms of MTBF? How many MTBF hours equal a known L10 life? This paper is an attempt to find some answers for these and similar MTBF-related questions.

Life and reliability related issues are based on tests and observation of components applying mathematical (statistical) evaluations and approximations, using appropriate functions and formulas. It is common practice to define characteristic values and choose "scientific" statistical methods to analyze and evaluate them. It is fairly easy to define certain characteristics of a selected number of test specimens by applying statistical methods for an observed population/group and come up with a "scientific, statistical conclusion." But to have realistic, meaningful conclusions, the definitions and the evaluation methods must be clear and transparent.

$$FR = \frac{\text{Number of Failures (NF)}}{\text{Observation Time (OT) x Population Size (N)}}$$

NF—Number of Failures (during the overall time period, at a certain time / time interval)
Failures: which type of failures? failure mode? which part? repairable non unrepairable? loading conditions environmental effects consistent?

OT—Observation Time (till a certain amount or all failed)
hours, days, miles, cycles, etc.

N—Population Size – overall number of units observed selected test units or large population of units in field?

Lab test? Field test? How far are the loads and operating conditions consistent?

Figure 1—Failure rate, FR.

This paper is an attempt to express the life and reliability of gearboxes in terms of MTBF without going into an in-depth discussion of statistical methods. As mentioned, MTBF is a widely used characteristic value to quantify reliability of electronic components and systems, but it is not commonly used for reliability assessment of mechanical components and systems.

For the correct interpretation of the MTBF value it is necessary to understand some basic concepts of probability of failures and the methods of their evaluation.

Failure Rate

The fundamental first step in determining the reliability and life of a component is to observe a representative set of samples—a "population" of components—and to record the failures over a certain time frame.

The collected data will show a certain number of failures over the observed time period. An absolute number of failures has no real practical meaning; it always has to be related to the observed population size. This is expressed by the failure rate.

Failure rate is the relative frequency at which a component or system fails in a given timeframe—i.e., failures/minutes, hours, years or within a certain time-related measure such as distance—i.e., failures/miles (in automotive field); or per operating cycles such as failures in one million revolutions (bearings), etc. As we can see, it is not an absolute number of units failed but rather a relative number, related to the size of the observed tested number of units and population of products (see Fig. 1).

Indeed, it would be more precise to call it the "relative failure rate" because the value is related to the overall observed population. The rate assumes a value between 0 (0% failures per hour) and 1 (100% failures per hour). This relative failure rate can be recorded at regular time intervals (for determining if and how the failure rate is changing over the life time), or recorded for a predefined period such as the "design life" of the component, assuming that the failure rate is constant during this period.

iPod example (Source: AppleInsider, July 27, 2006—"iPods Built to Last Four Years"): "Apple spokeswoman Natalie Kerris recently told the Chicago Tribune that iPods have a failure rate of less than 5%, which, she said, is 'fairly low,' compared with other consumer electronics. However, a survey conducted by MacInTouch last year found that of nearly 9,000 iPods owned by more than 4,000 respondents, more than 1,400 of the players had failed. The survey concluded that the failure rate was 13.7 %, attributed to an equal mix of hard drive- and battery-related issues."

$$FR = \frac{1400 \text{ failures}}{9000 \text{ units (2 years 365 days (12 hrs)}} = 0.000017757 / \text{hour}$$

Equation 1.

200000 K boxes are shipped/year

Warranty repair, return, failure 1%

Estimated average operating hours 8 hours/day

$$FR = \frac{4000 \text{ warranty returns}}{400000 \text{ units (2 years 365 days (8 hrs)}} = 0.000001712 / \text{hour}$$

Equation 2.

Remark. Based on the numbers, the actual failure rate should be FR = 1,400/9,000 = 0.155, or 15.5% for the observed time interval. Or, 15.55% – 13.7% = 1.8% failed for some reason other than that listed. Other explanations are also possible, but the survey does not list any.

Is Apple correct with the 5% value over the design life, or are the conclusions of the survey with 13.7% correct?

Here are some important questions before we take sides: Are both talking about the same type of failures? Does Apple consider the necessity to replace the battery a failure? How many units were surveyed by Apple? Is the population of 9,000 samples in the survey representative? (Apple ships in excess of 10 million units a quarter.) What was the real usage time or reference time of both observations? Does the statement "built to last four years" mean four years at 24/7 usage, or, for instance, only four hours a day, six days a week.

None of the above two failure rates gives any specific information about these important basis factors, nor about the conditions under which the data were collected. Let us assume that the survey was based on a 12-hour daily usage over a two-year period; the failure rate should be calculated as:

See above for Equation (1)

The example above highlights the main difficulty of the reliability/life calculation and the main source for misrepresentations, namely, the selection of the population, the observed time interval and failure mode, etc.

K-gearbox example. The right-angle, bevel-helical K-boxes have a two-year warranty:

See above for Equation (2)

Electronic components and systems such as a simple LED or complex processor chips are used in millions of computers or other devices under exactly defined and controlled conditions (certain voltage and clock frequency rate, temperature, etc.) On the other hand, gearboxes are subjected to a less-absolute range, and far less-controlled conditions, loads and environments. Also, the population size is substantially higher for electronic components than for gearboxes. Electronic components are routinely lab tested in high volumes. It is economically impractical to life test a large population of gearboxes or oth-

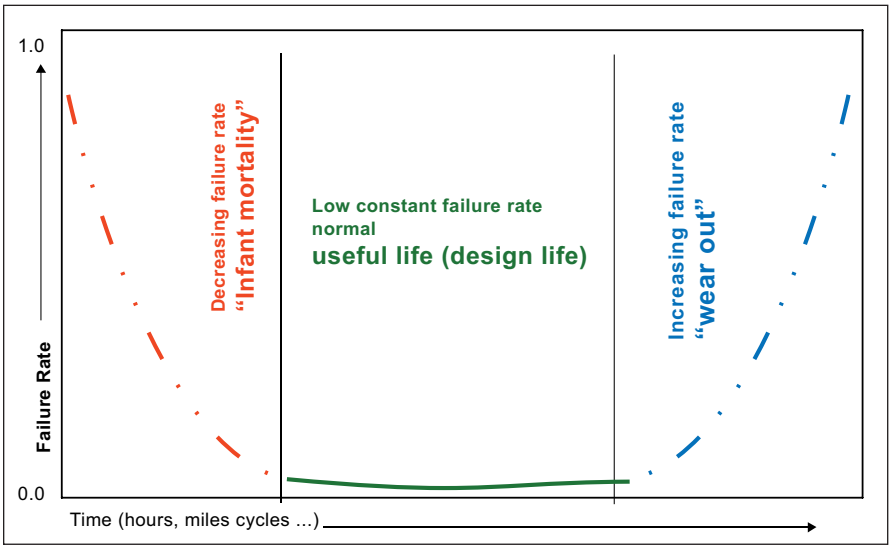
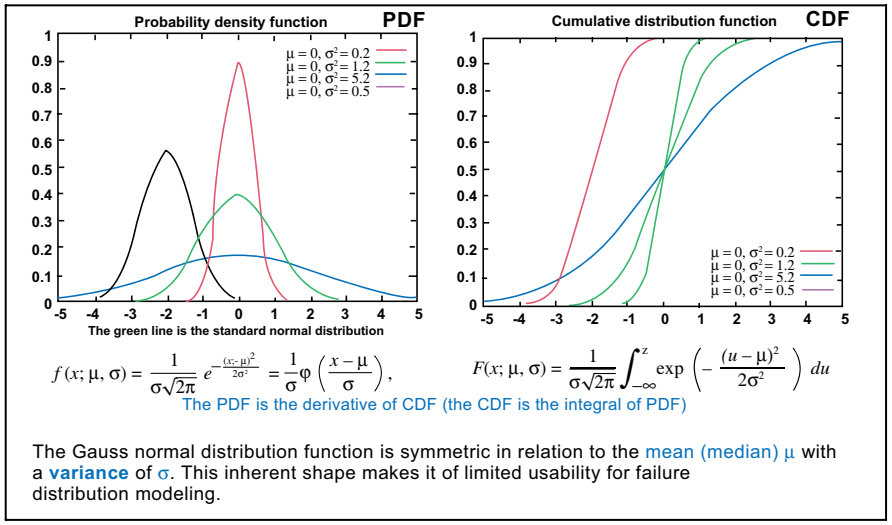
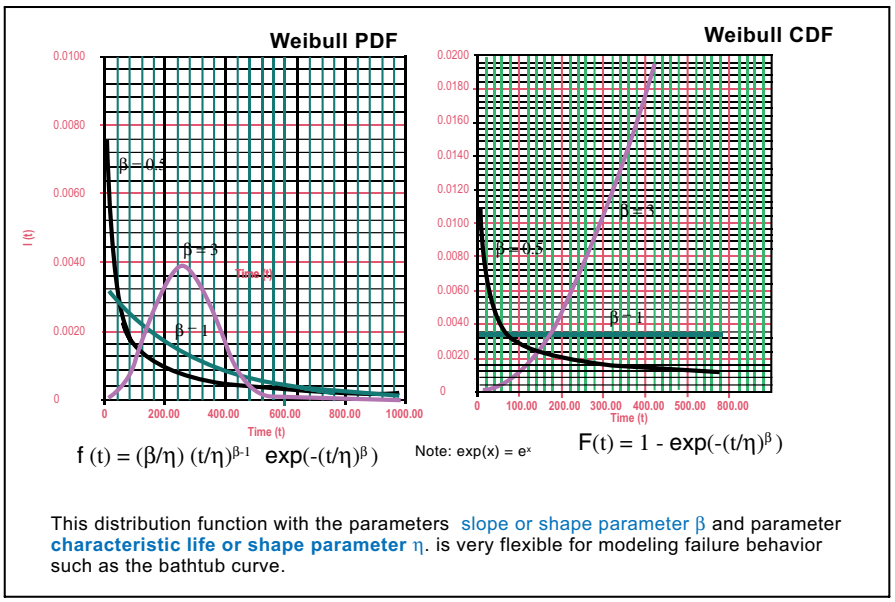


Figure 2—Bathtub curve.



The Gauss normal distribution function is symmetric in relation to the mean (median) μ with a **variance** of σ. This inherent shape makes it of limited usability for failure distribution modeling.

Figure 3—Gauss normal probability distribution function.



This distribution function with the parameters slope or shape parameter β and parameter **characteristic life or shape parameter** η. is very flexible for modeling failure behavior such as the bathtub curve.

Figure 4—Weibull probability distribution function.

er mechanical components, as well as securing exact same load conditions etc., in order to determine the "mortality" rate. Failure rate values result mainly from "field tests"—observations in real-world applications.

On the other hand, gearboxes are designed based on well-established, statically proven methods frequently regulated by standards put forth by AGMA, ISO, DIN, etc. Many components—bearings, for example—have well-known, statistically proven reliability and life characteristics. The shafts, gears and fasteners, etc., are all based on the endurance limit; there is theoretically no life limitation under the nominal load. This issue will be discussed further in relation to the two proposed methods of gauging gearbox MTBF.

Bathtub Curve

Most components follow the characteristic plot of failure rate over time, as shown in Figure 2.

The plotted failure rate over time for most engineered components and systems resembles the form of a bathtub, hence the name "bathtub curve." It has three characteristic areas—a) the "infant mortality" period, with decreasing failure rates; b) an almost-flat, nearly constant failure rate period, frequently called the "useful life period;" and c) the increasing failure or "wear-out" rate. The failure rate of living creatures, such as humans, also resembles the bathtub curve.

Electronic components have a very distinctive infant mortality. To minimize this impact on the reliability in practical applications, electronic components are frequently subjected to a "burn-in," which separates the early failures from the population. On the other hand, the wear-out of solid-state electronic components is far less significant.

Mechanical components, such as gears and gearbox components, behave differently in that there is no significant infant mortality. However, the wear-out can be significant. For obvious reasons, and in most practical applications, the useful life period is of greatest interest, not the reliability rate of the infant mortality period or during the period exceeding the design life—namely, the wear-out period.

Probability Density Function (PDF) and Cumulative Distribution Function (CDF)

The probability of an occurrence—or the probability of a certain failure rate—is mathematically described, approximated and analyzed by defining what is known as a suitable probability density function (PDF). The most common and well-known PDF is the normal probability distribution (Gauss distribution) applicable to many natural phenomena (Fig. 3). The area under the PDF—the integral of the PDF—is the cumulative distribution function (CDF).

And yet, the Gauss normal distribution function is not applicable to "bathtub curve" distributions (Fig. 4).

Whereas the normal PDF has the same basic shape for all parameters, the Weibull three- or two-parameter distribution function allows for widely different shapes of PDFs, depending upon the shape parameter. Weibull is well known to gear designers familiar with the bearing design and associated B-life ratings, which suggest that bearings should be compared at a life corresponding to 10% failure probability, or L10 life.

$$F(t) = 1 - e^{-(t/\eta)^{\beta}} \text{ or } R(t) = e^{-t/\eta^{\beta}} \qquad (3)$$

F(t) the Weibull cumulative distribution function CDF (here the widely used two-parameter distribution) provides the probability of failure. R(t) is "reliability," the complement of F(t) where:

t = failure time,

η = characteristic life, or scale factor

β = shape parameter or slope

e = Euler's number or Napier's constant (the base for natural logarithms)

For the three characteristic areas of a bathtub curve:

- The infant mortality—decreasing failure rate of the bathtub curve—corresponds to beta values <1;
- The useful life period—constant fail-ure rate—corre sponds to beta =1;
- The wear-out—increasing failure rate—corresponds to beta values >1.

In the Weibull probability plot, which is using an adjusted logarithmic scale, the distribution functions have the shape of a simple line where the slope is equal to the parameter β.

Furthermore, at a time t = η, 63.21% of the population will fail—independent of the β value—since F(t) @ t = η → 1-1/e = 0.6321.

In the Weibull plot, the horizontal line at 0.6231 failure rate has a special meaning (Fig. 5). For failure probability distributions with β =1, the t value corresponding to the intersection point of the F(t) line and the horizontal 0.6321 line can be interpreted as the mean time between failures. Note, this is only correct when β = 1, (constant failure rate) for that useful life region which is the scope of most practical considerations.

Also note F(t) = 63.21% failure probability means R(t) = 36.78% survival probability.

Mean Time Between Failures Distribution

It should be emphasized that in all practical component (gearbox) applications, the reliability during the useful life (design life) is what matters. This period is characterized by β =1 in the Weibull distribution.

The basic definition of MTBF is simple and logical, evidenced by its comparison to the definition of failure rate FR. The MTBF is the actual reciprocal value of the FR. MTBF = 1/FR (Fig. 6).

Let's calculate the MTBF for the two examples presented above.

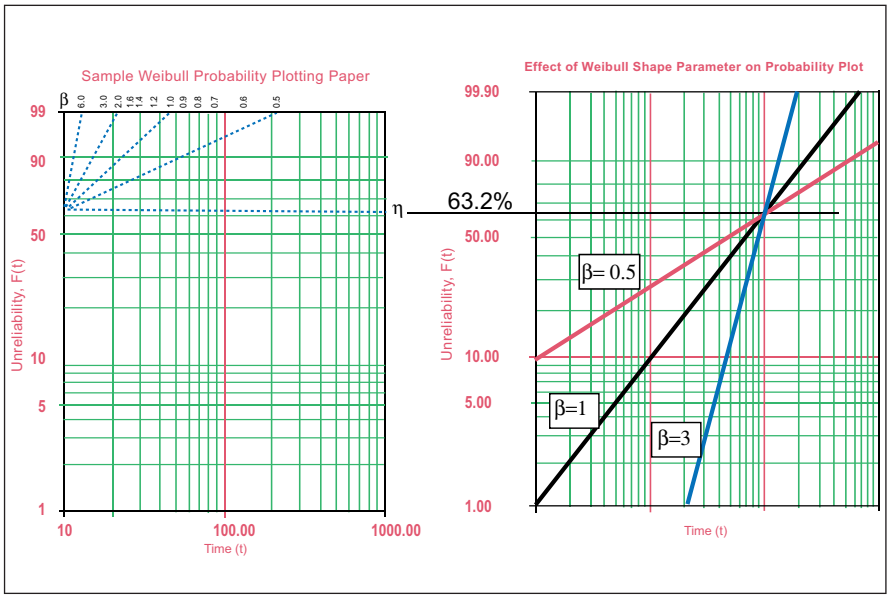


Figure 5—Weibull Plot.

$$\text{MTBF} = \frac{\text{Observation Time (OT) x Population Size (N)}}{\text{Number of Failures (NF)}}$$

NF-Number of Failures (during the overall time period, at a certain time / time interval) Failures: - which type of failures ? failure mode ? which part ? repairable non un-repairable ? loading conditions environmental effects consistent ?

OT- Observation Time (till a certain amount or all failed) hours - days - miles - cycles -

N- Population Size – overall number of units observed selected test units - large population of units in field -

..... Lab test ? Field test ? are the loads and op. - conditions consistent?.....

Figure 6—MTBF.

$$\text{MTBF} = \frac{9000 \text{ x } 2 \text{ years x } 365 \text{ days x12 hrs}}{1400 \text{ failures}}$$
$$= 5{,}631 \text{ hrs}$$

Equation 4.

200000 K boxes are shipped/year Warranty repair, return, repair, return, filure 1% i.e., 200000 unit x 2 years x 1% = 4000 units

Estimated average operating hours 8 hours/day

$$\text{MTBF} = \frac{(2{,}000{,}000 \text{ units})\ (2 \text{ yrs warranty})\ (365 \text{ days})\ (8 \text{ hrs})}{4000 \text{ warranty MTBF}}$$
$$= 584{,}000 \text{ HRS}$$

Equation 5.

4. Factor for other than 90% reliability

If other than the 90% reliability is required, the known value of L10 shall be multiplied by a reliability factor "fr" such that:

Ln - fr X L10
where Ln = rated life at the reliability of K% (n = 100 - K).

The values of the factor "fr" are presented in the following table.

Reliability, %	"Ln" rated life	"fr" reliability factor
50	L50	5.00
90	L10	1.00
95	L5	0.62
97	L3	0.44
99	L1	0.21

Example: L50 = 5.00 x L10

Figure 7—Relationship between bearing Ln and L10 life.

iPod example:

See above for Equation 4.

Obviously, we cannot expect that an iPod will last 56,314 hrs, or an equivalent of over six years of flawless operation.

K-gearbox example. Right-angle, helical bevel K-boxes have two-year warranties:

See above for Equation 5.

Here again the expectation that a K-box will last about 67 years under continuous operation would be a false interpretation of the MTBF value. But in comparing the two values, we can certainly say the K-box is about 10 times more reliable than an iPod.

The above examples calculated the MTBF based on field survey data and using a number of assumptions. As mentioned regarding failure rate, the population size, the observed time frame, consistency of loads and real operation time all influence the MTBF. Ideally, lab tests should be conducted on a large population of products, replicating the same conditions, in order to have an objective, comparable and representative MTBF value. However, it is not economically feasible to carry out extensive lab tests on products like industrial gearboxes. Too, the expense of running lab tests on hundreds of gearboxes for the period of their design life is not justified, even in high-volume products such as automotive transmissions.

Gearbox MTBF Determination

Obviously, the life and reliability of a mechanical system such as a gearbox also depend on the life/reliability characteristics of its other parts at a certain defined design load. Since testing a large number of gearboxes is not practical, the goal would be to determine MTBF values based on the design parameters and reliability characteristics of its components.

The main load-carrying components of a gearbox are the gears, shafts, shaft/hub connecting devices and bearings. Other secondary parts such as seals, fasteners, etc., are not directly involved in the torque transfer. Therefore their influence on the gearbox life is practically impossible to quantify simply from the design data alone.

Gears and Shafts

Remember, since products are designed and made for certain nominal loading (usage) conditions, the MTBF generally is referenced to these "normal" conditions.

Gears, shafts and hub/shaft connections are generally designed based on endurance (fatigue characteristics) design standards. These components should be selected and shaped to endure under the "nominal," i.e., rated, load conditions of unlimited load cycles. The stresses under the nominal load—the bending stress at the tooth root, for instance—must be below the endurance limit. The endurance limit values in themselves are not exact; they are statistical. For this reason the design standards include a number of sizing factors (size, surface, life factor, etc.) to adjust the endurance limit to in effect err on the safe side. Since they are based on endurance limits (theoretically unlimited life), it can be said that component designs based on endurance limits will not influence the MTBF. However, in real-world applications these components do fail, but mainly because overloads occur if, for example, they are loaded beyond the design specifications.

If the loads are above the nominal value, even if only occasionally, the life of these parts is limited. If the number, duration and magnitude of the load cycles above the nominal load are known, it is possible to estimate/approximate the life by using calculation methods such as the Palmgren-Miner linear damage hypothesis.

Bearings

Rolling element bearings, the other main component of a gearbox, have a different life characteristic in that they are not selected based on endurance limit, and their life is inherently limited. Their selection/design is based on standardized calculations rooted in statistical evaluations/methods. This fact makes it possible to approximate the life/reliability equivalent of bearings in terms of MTBF. That said, two alternatives are suggested here for the determination of the MTBF of a gearbox.

Proposed Alternative 1: Gearbox MTBF determination—based on warranty/repair figures.

The calculated MTBF value of gearboxes based on:

a) Observation time equal to the warranty time

b) Population equal to average amount shipped during the observation time

c) Number of warranty returns, or the percentage of the warranty returns as a number of failures, is a valid approach to determine the MTBF. Most manufacturers have these or similar values, typically established quality control personnel or a management system such as ISO 9000 (see example K-box above).

To have an honest, comparable MTBF value it would be beneficial to develop certain guidelines and standards for the collection of the above-mentioned data.

Proposed Alternative 2: Gearbox MTBF determination—based on L10 life. As discussed above, with Weibull distribution function at $\beta = 1$, the η value corresponds to the MTBF. The key mechanical components of countless mechanical systems are often the rolling bearings, and the L10 life of bearings is well-defined. Selection of bearings is based on this value. If, for example, a gearbox has bearings designed/rated for a 100,000-hrs, L10 life, that means there is a 10% failure probability or, conversely, a 90% reliability probability.

Discussing the Weibull plot at $\beta=1$, we concluded that the MTBF value corresponds to a 63.21% failure probability/36.78% reliability probability.

Ln values (L1 to L50) for bearings are listed in terms of the L10 in engineering literature, such as Ln = FR × L10. This is based on many years of tests and field data.

While the literature lists values up to L50, no explicit L63.21% value is found. However, extrapolating graphical curves Ln = f (L10) indicates that the FR value at 63.21% reliability is around 8.5.

We can therefore conclude that in (gearbox) systems where the rated life is mainly based on the L10 bearing value, the MTBF is equal to: MTBF = L10 × 8.5

But with that, it must be remembered that in many gearboxes the bearings are considered as wear parts, which can and should be periodically replaced. Using existing predictive maintenance techniques, bearings can be kept in operation far longer than their designed L10 life. Predictive maintenance can also indicate when to replace a bearing, regardless of its designed L10 life, thereby avoiding consequential damage to the gears and other components. The above approximation of the overall gearbox MTBF, based on the L10 value, is rather conservative. In many gearboxes, the bearings are not actively involved in the torque transmission, but still have the vital function of supporting the torque-transmitting components. On the other hand, with some gear types such as epicyclical or planetary gears, the bearings are directly involved in the torque transmission, as with the needle bearings of planet wheels.

Example: PLE Planetary gear head. The needle bearings of a PLE planetary gearbox are designed for 30,000 hrs. L10 life at rated torque. The gears are designed based on the endurance limit at rated torque. In planetary gears, the planet gear bearing is the vital part in the torque transmission, subjected to loads proportional to the transmitted torque. Thus the MTBF of the PLE gear head can be calculated as:

MTBF = 30,000 × 8.5 = 255,000 hrs

Conclusions/Suggestions

MTBF is a frequently used value to quantify reliability of electronic components and systems. It can certainly be used to state the reliability of mechanical components and systems if the basic rules are followed and interpreted correctly.

The proposed two alternatives determine the MTBF of a gearbox using data which, in many cases, are readily available to the gearbox manufacturer and designer. However, the first suggested method—based on warranty figures and field tests—provides a more balanced and complete realistic reliability assessment than the suggested second alternative, based on L10 bearing life.

As a result, the MTBF value determined by methods one and two for the same gearbox will differ significantly, in most cases. Therefore, when listing an MTBF value, it should be noted which approach is used. The bearing base method is only recommended if field test-based values are not available.

It would be beneficial to develop and publish appropriate AGMA guidelines, recommendations or standards to make the used data consistent, thus making the MTBF values of different gearboxes comparable.

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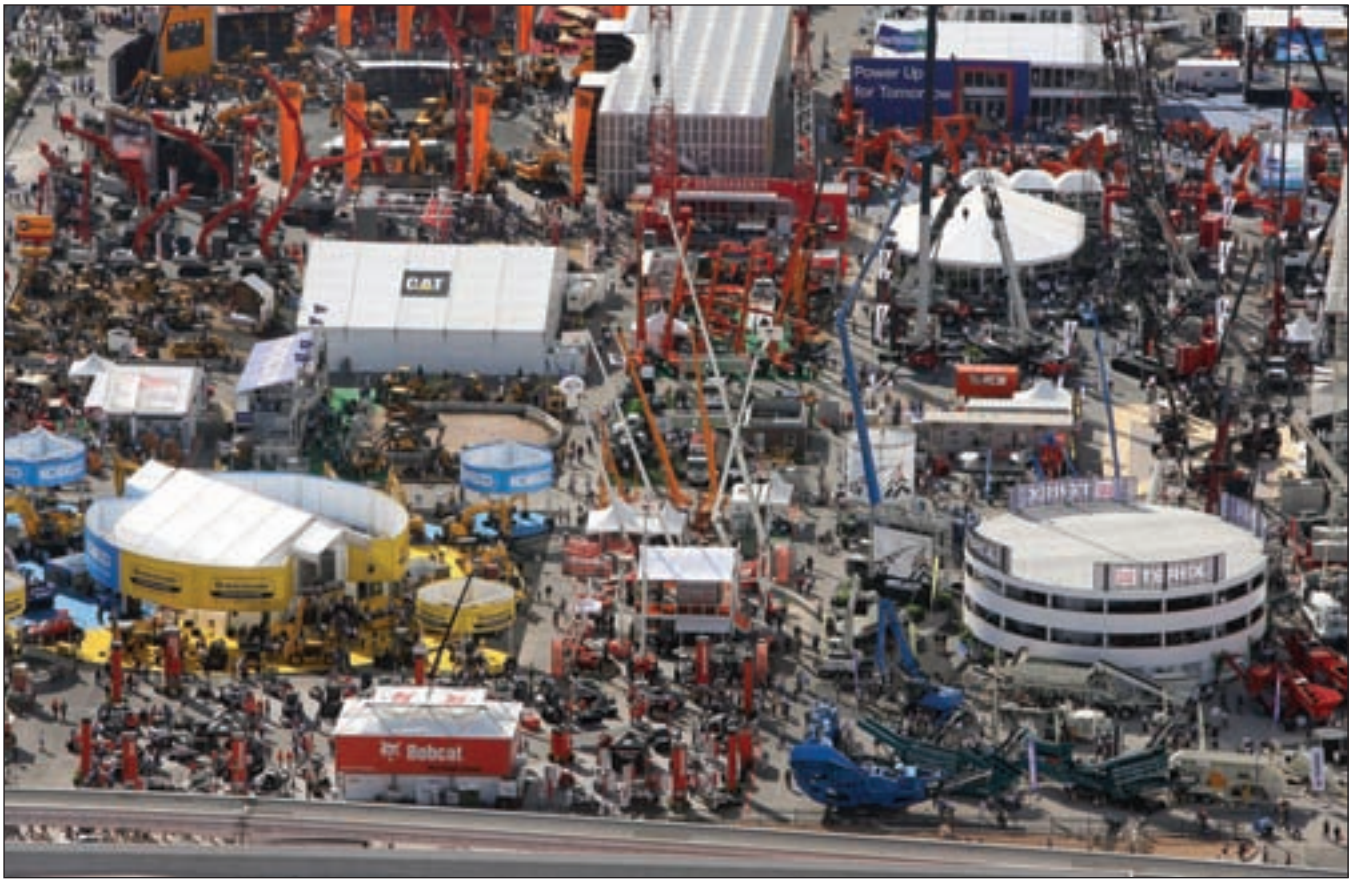
A Record-Setting Week at IFPE 2008



With its labyrinth of cranes, cement mixers and Mack trucks, the entrance of CONEXPO-CON/AGG and IFPE 2008 looked more like a carnival than a trade show. The sights and sounds of drills, saws and engines, however, reminded guests they were heading into a construction, aggregates and ready-mixed concrete exhibition, boasting more than 18 billion pounds of freight.

Fortunately, walking sticks were provided to get around all of it.

Beyond all the bells and whistles of CONEXPO-CON/AGG, IFPE 2008 was quietly taking place on the 2nd floor of the South Hall at the Las Vegas Convention Center. Here, among the suppliers of hydraulic, pneumatic, electrical and mechanical power transmission products, trade show life was less invasive and not so noisy.

According to convention organizers, the CONEXPO-CON/AGG and IFPE 2008 trade show attracted record numbers with more than 144,600 in attendance from March 11–15. IFPE 2008 was the largest in its history, showcasing 129,000 square feet of exhibit space used by 469 organizations.

The conference offered 111 papers from industry experts as well as registration from more than 1,700 participants for the education sessions. More than 530 industry-related meetings were held in conjunction with the trade show.

While the South Hall did not share the circus atmosphere of the outdoor lots, companies including Oerlikon Fairfield, Bosch Rexroth, Parker Hannifin, Gates Corp. and the National Fluid Power Association (NFPA) did their fair share to garner some attention with prominent exhibits on the 2nd floor.

Oerlikon Fairfield, for example, built a two-story extravaganza with a coffee bar. The Gates Corp. displayed a Harley-Davidson motorcycle suspended in mid-air by one of its poly chains. The NFPA offered guests leather couches to escape from the cluttered exhibition hallways.

By mid-afternoon on Thursday, March 13, the exhibition floor was wall-to-wall people with attendees making contacts, testing new equipment or simply comparing products. Although a few exhibitors felt the show was almost too big to see everything, most were happy with the relationships, both old and new, that came out of IFPE 2008.

"We've been really busy here for three days," says Melissa Piano, marketing services manager at Parker Hannifin. "It's been a little chaotic at times, but we've had very good conversations with the people we came here to talk to. This is a great outlet for Parker."

Ted Han, general manager of engine sales at Mitsubishi Engine, was impressed with the foot traffic over the course of the week. "We've been to bigger shows in Asia, but this is the most feedback we've gotten from customers at a North American exhibition. We look forward to returning to IFPE in 2011."

While most organizations arrived at IFPE to market specific products and services, the American Gear Manufacturers Association (AGMA) had an entirely different agenda.

"People keep coming up to our booth asking what it is we're selling and we tell them we're here simply to promote our members," says Jan Potter, vice president at AGMA. "This has been a very productive show for our organization. We literally have people from all over the world here promoting the gear industry. It's nice to have several of our members sharing space here in the gear pavilion."

The AGMA gear pavilion was just one of the many focus areas on the IFPE show floor. Other areas included the sensors

Attendees of the Innovation & Solutions Center gained industry knowledge with 19 free education sessions. (Images provided by Oscar Einzig Photographers.)

pavilion, the Power Transmission Distributors Association (PTDA) pavilion as well as international booths from China, Italy, Spain and Taiwan.

These specific booths ultimately created a concentrated area for exhibitors that provided similar products and services, a well-planned move by show organizers.

Regrets—just as Frank Sinatra once proclaimed—well, there were a few.

Some attendees had little or no time to see much of anything outside the South Hall. People were constantly flipping through maps and directories hoping to find a particular education session or program. The ebb and flow of the foot traffic, in fact, greatly depended on the mission of the attendees.

"It's such a large show, people have to have a determination to see who they want to see before it's over," says Allen Graham, WEG south central area manager. "For those who attend with certain goals in mind, I feel it's a great opportunity. They miss the chance to see some really great things if they're just walking around without a purpose."

The organizers and developers of IFPE 2008 should be properly commended, however, for jumping through all the hurdles needed to pull off an exhibition of this size. Hosting IFPE 2008 with CONEXPO-CON/AGG allowed many in the industry to meet the people they needed to meet from all the different facets of the manufacturing community.

Show organizers believe the event alone brought the city of Las Vegas more than $233 million in revenue, not counting what visitors lost at the craps, roulette and blackjack tables during off hours.

From a general perspective, the attendance numbers and overall attitude of the guests proved that U.S. manufacturing seems to be doing all right at the start of 2008. How long this will last depends on whom you talk to.

The next edition of the CONEXPO-CON/AGG and IFPE show will take place March 22-26 2011 at the Las Vegas Convention Center. For more information, visit www.ifpe.com.

ONLINE

Visit

www.powertransmission.com

for the latest Calendar Items

calendar

April 21–24—International Pump Users Symposium. George R. Brown Convention Center, Houston. The only meeting organized by pump users for pump users features a full-scale trade show with in-depth short courses, case studies, discussion groups, hands-on tutorials and lectures. These technical sessions are staggered to offer flexible scheduling for attendees. Members of the pump industry can find solutions for maintenance, performance, troubleshooting, operation and acquisition of pumps. All exhibits are free and open to the public, and the products displayed come from various key companies in the industry such as GE, Lufkin, John Crane and Eagle. For more information, visit *turbolab.tamu.edu/pumpshow/pump.html.*

May 31–June 3—Society of Manufacturing Engineers Annual Meeting and Interactive "Unconference." Marriot Renaissance, Detroit. Anyone passionate about manufacturing, SME members and non-members, is welcomed to this year's event to learn the latest happenings in manufacturing, share ideas and success stories, exchange best practices, develop resources and connections and collaborate with other industries and technologies. The event will also highlight how SME helps advance manufacturing education and support the industry. Some activities include lean-in-action industry tours, SME chapters and technical communities' poster competition, industry keynotes and networking functions, SME International Awards Gala, interactive member center, SME annual business meeting and an opening reception and tour at the newly remodeled Detroit Institute of Arts. For more information, visit www.sme.org/annualmeeting.

June 1–4—WINDPOWER 2008 Conference and Exhibition. Houston. The largest conference and exhibition of wind energy in North America is sponsored by the American Wind Energy Association (AWEA) and arrives in the energy capital of the world for three days of conference sessions, an interactive tradeshow of wind energy products and services and, of course, industry networking opportunities. The exhibition has grown substantially, necessitating an increase of show floor size and anticipating over 550 exhibitors and more than 8,000 attendees. The WINDPOWER conference program includes speakers and moderators, poster presentations and sessions on chief wind energy topics organized into focus groups for policy, business and technical concentrations. This year's conference is scheduled to address the actions required to maintain wind energy's position as a central piece of the U.S. energy mix and to ensure its continued growth. For more information, visit *www.windpowerexpo.org* or contact Lori Rugh at *lrugh@awea.org* or (661) 821-2149.

June 8–12—World Congress on Powder Metallurgy and Particle Materials. Gaylord National Hotel, Washington, D.C. Held every six years in North America, the 2008 PM World Congress attracts the world's leading technical minds in the powder metallurgy and particle materials industry. Events include a general technical session, poster program and special interest program. Exhibitors planning to attend the event include Abtex, Battenfeld of America, Erasteel, CM Furnaces, Inco Special Products, H.W.F. Inc., Metal Processing Systems Inc., Fette Compacting, Plansee Group, Lonza Inc., Smart Materials, and many more. The event is sponsored by the Metal Powder Industries Federation (MPIF). For more information visit *www.mpif.org* or call (609) 452-7700.

June 8–13—Design Automation Conference. Anaheim Convention Center, Anaheim, CA. The 45th DAC is an opportunity to educate and network about the design of electronic circuits and systems, electronic design automation (EDA) and silicon solutions. Representatives from more than 1,500 industry organizations worldwide are present, including system designers and architects, logic and circuit designers, validation engineers, CAD managers, senior managers, executives and university researchers. Learn about recent developments, trends, management practices, new products, methodologies and technologies from 60 or so technical sessions chosen by electronic design experts. One special element is the exhibition and suite area, where around 250 EDA, silicon and IP providers demonstrate advanced products, technologies and services. The DAC is sponsored by the Association for Computing Machinery's Special Interest Group on Design Automation (ACM/SIGDA), the Circuits and Systems Society and Council on Electronic Design Automation of the Institute of Electrical and Electronics Engineers (IEEE/CASS/CEDA) and the Electronic Design Automation Consortium (EDA Consortium). For more information, visit *www.dac.com*.

June 23–25—Device Research Conference. University of California, Santa Barbara, CA. The main goal of the Device Research Conference is to encourage discussion about recent breakthroughs and advancements regarding electronic and optical devices with a technical program presenting invited, oral and poster seminars. The event is attended by scientists, researchers and graduate students from a variety of fields. A rump session is scheduled for each evening; they intend to stimulate dynamic discussion with the audience about the future of competing device technologies. Graduate students are strongly encouraged to participate by competing for a best student paper award, and travel support is provided for them by the conference committee. The Device Research Conference is being coordinated with the Electronic Materials Conference, also held at the university the same week. Wednesday, June 25 features a joint session to focus on the importance of using materials and devices mutually to advance future purposes. For more information, visit *drc.ee.psu.edu*.

Bishop-Wisecarver

AWARDED PATENT FOR INTEGRAL GUIDE WHEELS

The U.S. Patent and Trademark office granted Bishop-Wisecarver a second patent for their DualVee guide wheel product line. The integral guide wheels, the latest addition to the DualVee line, which was patented in 1967, include a one-piece design with the stud or bushing integrated into the wheel, and they are made in carbon steel or polymer varieties. A machined inner bearing race is included in the larger-size models, and the smaller sizes feature a swaged retaining technology to fasten the wheel to the stud. The integral wheels have a lower profile and larger diameter fastener, supplying more rigidity and mounting torque capacity, according to the company's press release.

"We are very pleased to have been awarded a second patent for our core technology," says Pamela Kan, Bishop-Wisecarver president. "The acceptance of this patent clearly defines Bishop-Wisecarver's history of innovation, and further reinforces our position as the pioneer and industry leader of guide wheel technology. We are committed to our mission of providing motion without limits."

Visit *www.bwc.com/products/dual-vee.html* for more information on DualVee integral wheels.

Ramsey Industries

ACQUIRES ESKRIDGE

Ramsey Industries Inc. adds Eskridge Inc. as the company's third subsidiary in addition to Auto Crane, a brand offering truck-mounted telescopic cranes, crane service bodies and accessories, and Ramsey Winch, which provides various industrial and consumer winches. Ramsey Industries sells products to end-user markets including non-residential construction, oil and gas, towing and recovery, municipal, mining and energy/utilities. Eskridge will continue to be based out of Olathe, Kansas as a designer, manufacturer and marketer of planetary gear drives, auger drives and multiple-disc brakes for sale to distributors and OEMs, according to Eskridge's press release. The companies' different product lines are expected to complement each other well.

"Our vision is to become a global leader in all of the markets we serve by providing innovative solutions to our customers' requirements with high-quality, on-time and cost-effective products," says Bruce Barron, CEO of Ramsey Industries. "The acquisition of Eskridge brings us one step closer to the accomplishment of that goal. This combination will increase the offering of products to our valued customers around the globe and will also allow us to offer them full package solutions to their growing needs."

NEMA

INDEXES EXPRESS FLUCTUATIONS

The Primary Industrial Controls Index experienced healthy growth in 2007, rising 8.3 percent in the fourth quarter, but the index appears as though it will decline in 2008. For the entire calendar year, the index grew 6.2 percent, proving to be the most successful year of growth since 2004 and reached the highest level since 1997. The National Electrical Manufacturers Association's (NEMA) Primary Industrial Controls and Adjustable Speed Drives Index, measuring broader demand for industrial controls, rose 6.7 percent over the previous quarter and 11.4 percent on a year-over-year basis. For the entire year 2007, the index was up 7.9 percent.

Over the past few months, the U.S. economy experienced stunted growth as consumer spending was at its slowest in years, residential investment declined considerably, inventories shrunk and the balance of trade was weak, even with the declining dollar. GDP growth surged in the third quarter of 2007, only to relatively freeze for the last quarter. Business investment was brighter, growing steadily due to spending on nonresidential structures. These factors indicate that prospects for the manufacturing sector are dimming and industrial control shipments are likely to weaken in 2008.

NEMA's Motors Shipments Index showed similar tendencies in 2007, shrinking 7.3 percent quarter-to-quarter during the final three-month period of the year. The index slipped almost 7 percent on a year-over-year basis, imitating

similar activity from four of the last five quarters. After showing double-digit growth the past two consecutive years, the index declined 3.5 percent over the full calendar year. These discouraging numbers are the result of a sharp fall in fractional horsepower motor shipments linked to the U.S. housing market slump; however, recent integral horsepower motor demand has been sturdy during the recent dips. On a more upbeat note, the industrial sector is anticipated to experience positive growth in the near future, due to export demand, business investment and inventory replenishment.

Altra

APPOINTS NEIL ENGLISH AS EUROPEAN DIRECTOR OF SALES

As director of European sales for Altra Industrial Motion, Neil English will be responsible for overall sales within Europe for Altra's range of global brands, including Warner Electric, Matrix International, Wichita Clutch, Stieber, Twiflex, Bibby Transmissions and Huco Dynatork.

Neil English

Prior to this appointment, English was most recently the sales and marketing director for Holroyd, a machine tool manufacturer. He worked at the Engineering Construction Industry Training Board, where he increased client and customer engagements by 150 percent, Altra's press release says. English also held a senior sales role with Sumitomo, a Japanese power transmission company.

"This is an exciting time to be joining Altra," English says. "The company is in a massive growth phase, as emphasized by the company's organic revenue global growth of 9.9 percent for the third quarter of 2007. This growth is being driven by its management team's continuous focus on new products and target markets all aided by Altra's unique business system, which focuses on improvements in quality, delivery and cost to drive customer satisfaction. Altra's business system also provides the tools to achieve specific business objectives with the involvement of all associates."

Rotork

OBTAINS REMOTE CONTROL SWEDEN, DRALLIM VALVE TESTING PRODUCT

Rotork increased its Fluid Systems division with the acquisition of Remote Control Sweden, which manufactures pneumatic valve actuators and associated control systems. Remote Control Sweden was under the ownership of Per Larsson and has been an international trader since 1961. Rotork expects the acquisition to offer a range of supplemental products and industry opportunities, and RCS merchandise will continue using their current sales channels and international network for marketing purposes, according to Rotork's press release.

"RCS complements Rotork's existing medium- to heavy-duty range of pneumatic and hydraulic actuators and brings with it a reputation for quality and service, strengthening our reputation as the actuator company of choice. The acquisition increases our ability to provide a single source for these products and enhances our presence in existing and new market areas," says Alex Busby, managing director of Rotork Fluid Systems.

Rotork has also purchased the Drallim SVM (smart valve monitoring) partial stroke valve testing product from Drallim Industries Limited. The product is designed to help test hydraulically and pneumatically actuated block valves, which are typically used for emergency shutdown, blow down, high-integrity pressure protection and sub-sea isolation. The SVM technology allows users to evaluate if a valve will close as expected and how all the final components in the valve loop are working. The performance data can be used to calculate any issues in the partial stroke valve operation to help avoid potential failures or machine shutdowns, according to Rotork's press release.

SVM technology specialist Richard Harvey is transferring from Drallim as part of the sales agreement, and he will be the SVM product's business development manager for Rotork.

"The purchase of this innovative technology provides us with a platform to further develop our products for safety-critical applications," Busby says.

Rexroth

APPOINTS PLC AND HMI PRODUCT MANAGER


Ted Thayer

Ted Thayer has been named PLC and HMI manager for Bosch Rexroth Corporation; he will be responsible for PLC and HMI product releases, maintaining and developing customer and partner relationships and executing PLC training initiatives for Rexroth's Electric Drives and Controls technology group.

Before working for Bosch Rexroth, Thayer directed call center operations, supplied technical support for industrial automations products and instructed several training classes for the Technical Assistance Center at Mitsubishi Electric Automation. He cultivated a product training program and contributed to sales efforts with Chrysler, U.S. Postal Service, Corning and Applied Materials. He has held several engineering positions, including applications engineer, associate controls engineer and senior development engineer. Thayer earned a bachelor's degree from Northern Illinois University in electrical engineering technology and a master of business administration degree from the University of Phoenix, and he graduated from DeviceNet University. He is also certified as a project management professional, Profibus engineer and support center supervisor.

AMT

WELCOMES NEW VICE PRESIDENT-BUSINESS DEVELOPMENT

Jeffery H. Traver brings more than 22 years of manufacturing operations management experience to AMT when he replaces Steven Thiry after a transitional period. Traver will be in charge of the department accountable for marketing and business development assistance to members in both the domestic and international spheres, helping members maintain the drive for market penetration and increased competitiveness goals. Three AMT representative offices will report to him, including the Shanghai Technology and Service Center, the Technical Center and offices in Mexico and the Chennai Technology and Service Centre opening this year in India.

Traver worked for the General Electric Company for 13 years, initially in turbine business operations before taking a management position in the electrical distribution and control business and eventually moving to Europe to help GE's power control business.

He spent time as the vice president of marketing for ABTCO, a privately-held maker of hardboard, fiber cement and wood chip products, before he headed to the Harbour Group, where he worked in management consulting. Traver also served as the senior vice president and COO of C-Tech Industries, a company that manufactures high-pressure cleaning equipment.

Traver has a bachelor's degree in mechanical engineering from Pennsylvania State University and a master's degree in management engineering from the University of Bridgeport.

"Jeff has the ideal background to continue the innovative programs AMT has initiated under Steve Thiry's guidance," says AMT president John B. Byrd III. "His varied background in manufacturing management and consulting will enable AMT to continue to offer new programs and services to its members."

Bison

WELCOMES TODD LUCICH AS VP OF SALES

As the new vice president of sales at Bison Gear and Engineering Corp., Todd Lucich brings with him 27 years of power transmission industry experience. He held several sales and product management roles with Rockwell Automation before he became vice president of distribution and national accounts for Rexnord Industries. Lucich earned a bachelor's degree from Western Oregon University, and he has two patents for engineering innovation.

"We are excited to have Todd on board at Bison. We believe his experience will grow our sales team to new directions in the future," says Martin Swarbrick, Bison CEO.

Hansen

ELECTS GERD BERSCH AS CORPORATE DIRECTOR OF STRATEGIC PROCUREMENT

Global gearbox designer, manufacturer and wind turbine gearbox market supplier Hansen Transmissions International N.V. has appointed Gerd Bersch as the corporate director of strategic procurement. Bersch will help institute supply networks for the worldwide wind energy business. Bersch possesses previous supply chain management experience, some of which included gearbox production at companies like Schottel GmbH, Flender AG, Koenig & Bauer AG, ABB Kraftwerk AG and Volkswagen AG.

"Gerd Bersch is a valuable new member of the Hansen team. Establishing efficient supply networks in the shortest possible time frame will enable us to continue to grow our output quickly and to seize the exciting opportunities we are presented with. We welcome him to Hansen Transmissions," says Hansen CEO Ivan Brems.

alpha and Wittenstein

OPENS SALES OFFICE IN CANADA

alpha and Wittenstein, supplier of motion control components and systems, launched the North American Global Center of Excellence in Ontario. In the near future, the company intends to open other North American sales offices similar to this one, in addition to various pre-existing U.S. offices around the country. The contact information for the new office is as follows:

For more information:

alpha gear drives, Inc.
427 Dundas St. E.
Waterdown, ON LOR 2H1
Canada
Phone: (905) 690-7086
Fax: (905) 690-7084

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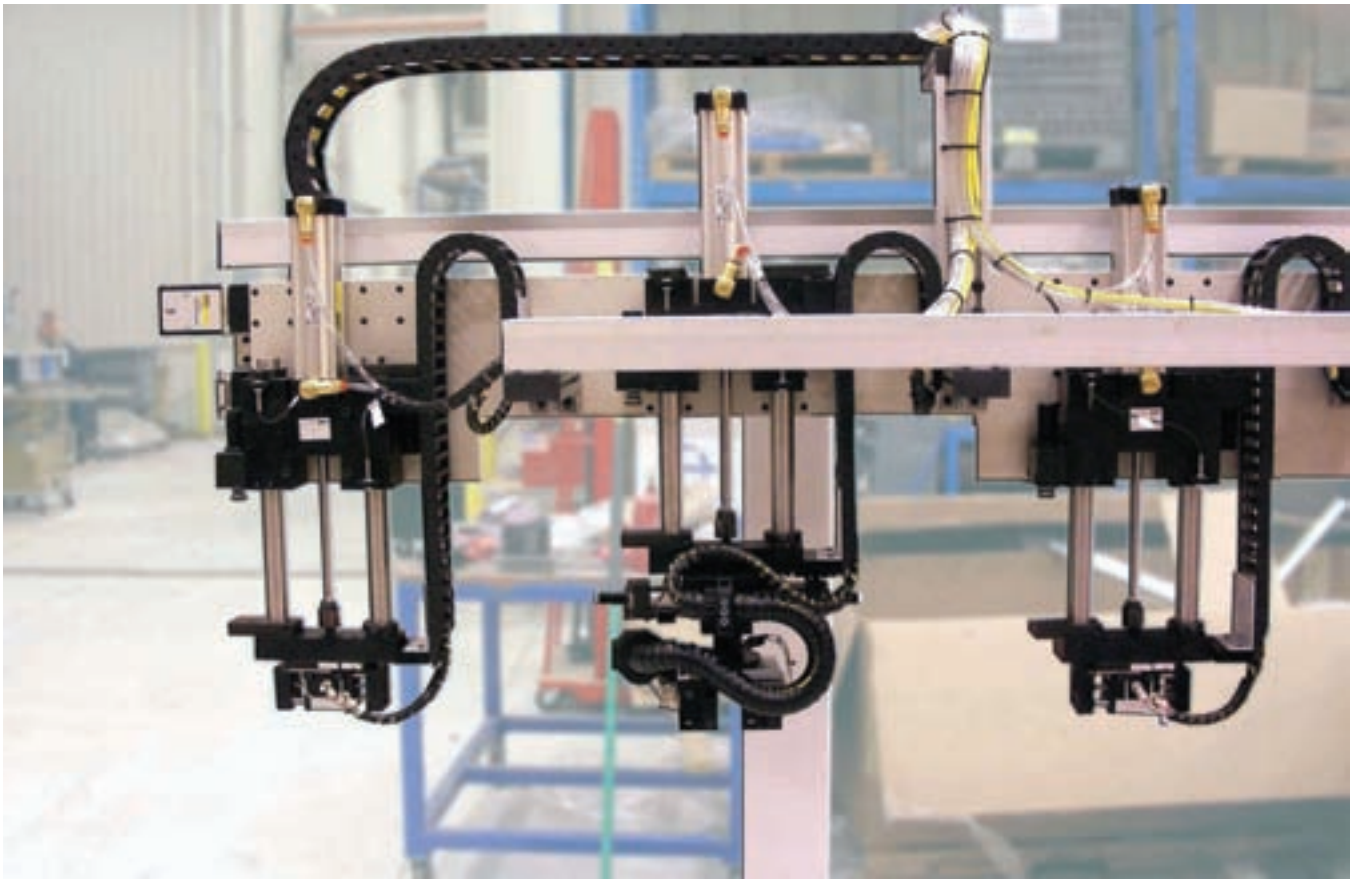

Parker Sorts 76,800 Bottles of Beer an Hour

And has the YouTube video to prove it.

There may be 99 bottles of beer on the wall, as the song suggests, but it's no longer necessary to take one down and pass it around if you've got the right motion control device in place. Automation is still the name of the game in manufacturing, and Parker Motion Control Systems is providing the necessary components to make it happen—76,800 times an hour.

At Beck's Brewery in Bremen, Germany, Recop Electronic sorts empty beer bottles using Parker automation products. Here in the heart of the distribution center, Parker provides the gantry system and the Compax3 servo drive/controllers for the recycling operation.

The system was built to make sure the right type of bottle is put in the right type of crate for the recycling process. Essentially, the motion provided on the system is the heart of the machine. The belt drives move the pneumatic "head" around to pick and place the bottles, and the Compex3 handles all the intelligence needed to process the commands. Parker provides many of the components.

Ben Furnish, linear products manager at Parker, believes offering several different components to Recop was the reason they were tapped to work on the project in the first place.

"The ability to source as much or as little as you need for the machine from one ISO-certified corporation with global support and expertise in motion and control is a great advantage," Furnish says. "So many suppliers only offer a limited amount of components, forcing customers to work with multiple vendors and the challenges associated with products not mounting together."

The equipment used on the sorting machines is used in several other industries as well. The HPLA belt has been utilized in the semiconductor, LCD, glass cutting, packaging and palletizing industries. The Compax3 is being used in alternative energy, packaging, converting, liquid dispensing, automotive and many others. Parker is launching an Ethernet powerlink version of the Compax3 so the markets will have faster transfer capabilities and real-time data benefits.

Florian Zettl, project manager at Recop, chose Parker products because of the cost and the reliability of the components. He feels that after two to three years of service, Parker's products have a proven track record. "The system functions perfectly, which is the main we reason we continue to work with Parker today."

To promote their motion control products, Parker is now sharing videos with the world via the website YouTube. It gives the company an opportunity to explore new avenues in advertising.

"YouTube has provided a storage location for interesting videos for us to archive," Furnish says. "We've just begun to test the waters and see how this can benefit our advertising or promotional efforts. Early indicators show we receive more hits through word of mouth, but those hits are difficult to track to orders or actual sales dollars."

When Parker isn't solving the beer bottle crisis, the company is involved in projects like space explorers, missile launchers and electric scooters. To see how the sorting machine works, visit *www.youtube.com/watch?v=eHr3jo5oNxs*. For additional information, visit *www.parkermotion.com.*

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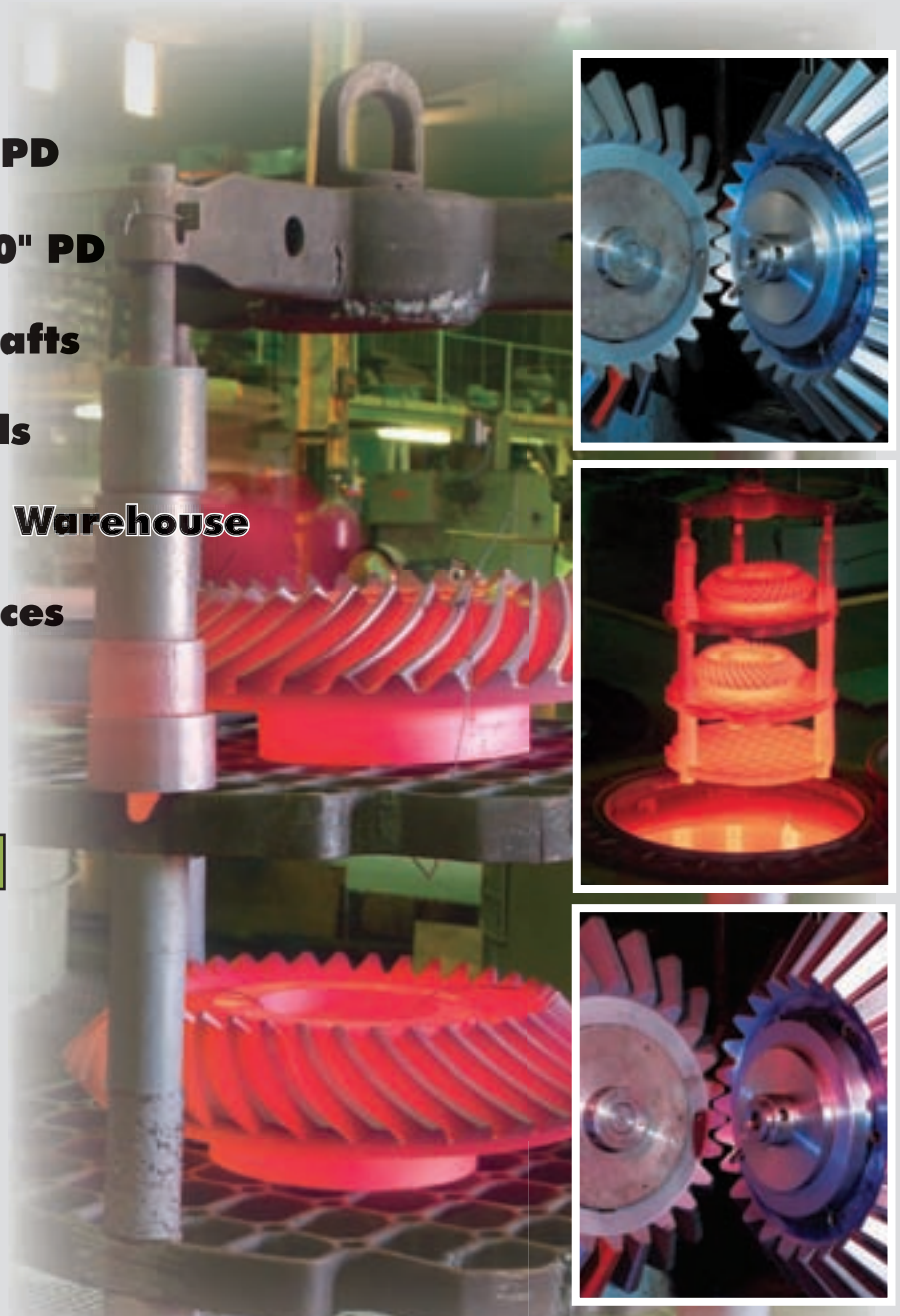

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