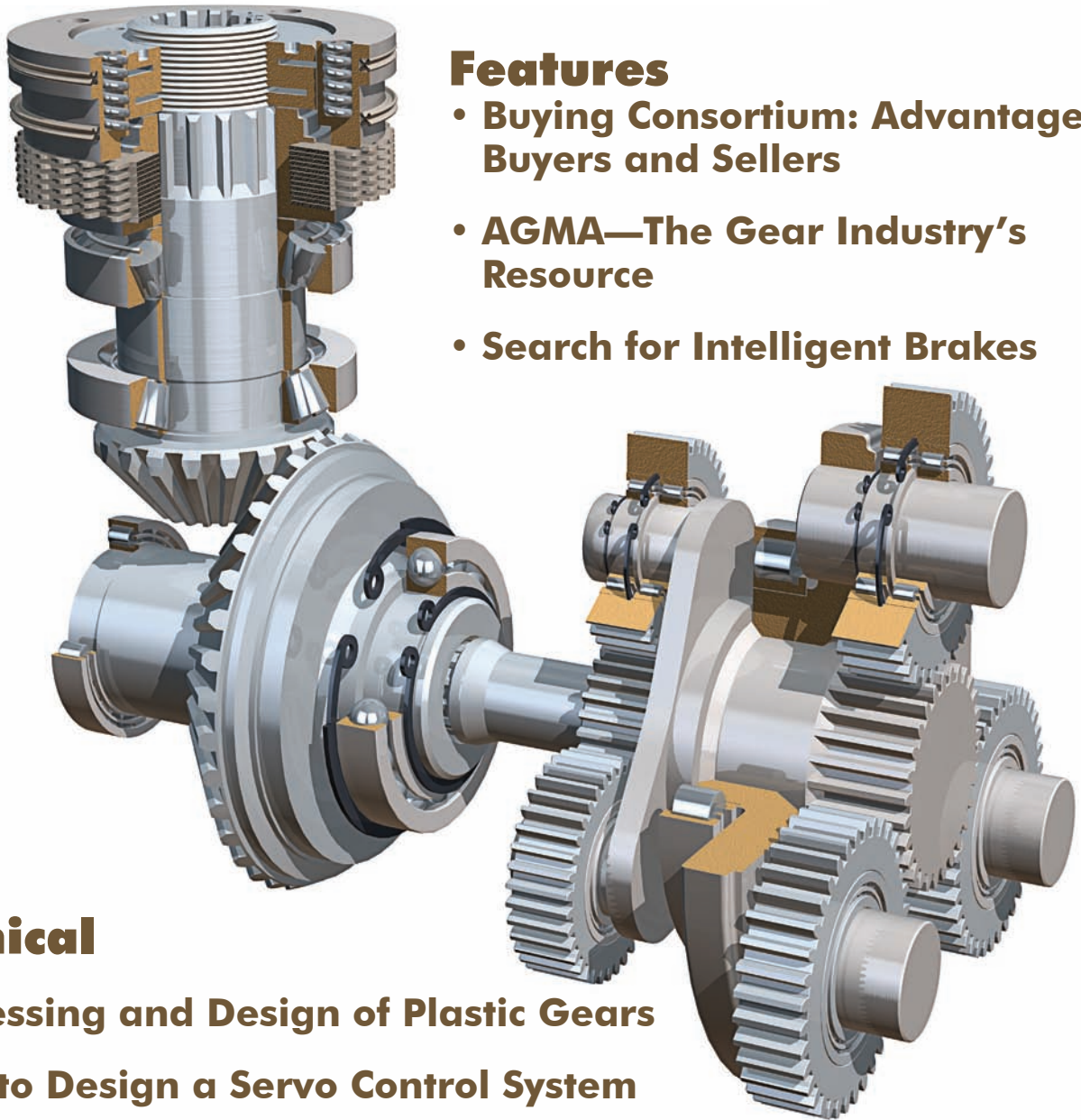


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- **Buying Consortium: Advantage Buyers and Sellers**
- **AGMA—The Gear Industry's Resource**
- **Search for Intelligent Brakes**

Technical

- **Processing and Design of Plastic Gears**
- **How to Design a Servo Control System**
- **Bearings for High Temperatures**

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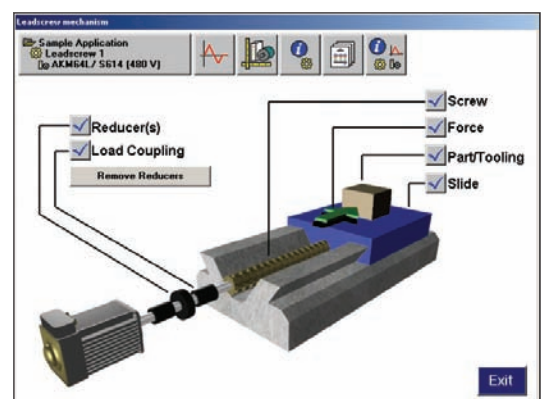
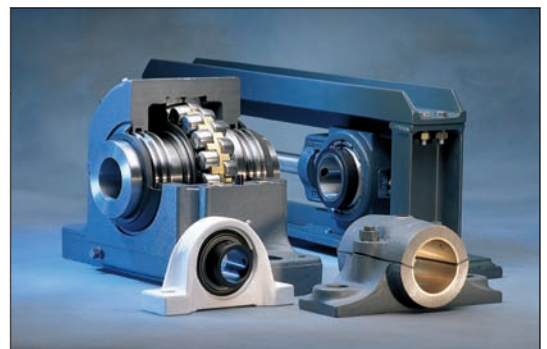
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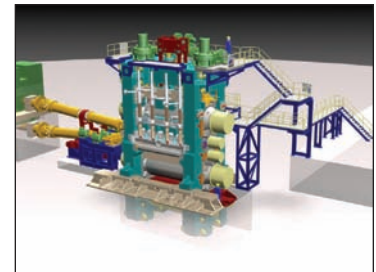
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- Bearings for High Temperatures

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MEMS-Based Systems

MAKE A LOT OF SENSE

Bigger is better in most cases, but not when looking for cost-effective sensing upgrades in such industries as industrial automation, power transmission and motion control, among others. Companies in a number of manufacturing sectors—automotive and transportation, product testing, medical device, energy and power systems, e.g., are augmenting or completely retrofitting their older-generation electro-mechanical sensing capabilities with MEMS—micro-electro mechanical systems. In fact, industry figures state that the MEMS device market is expected this year to reach \$7 billion in U.S. sales. (MEMS are sensor- and actuator-based systems with performance derived from mechanical features measured in microns.)

As you might discern, the key word here is “micro,” as in a-heck-of-a-lot-smaller than the mature-technology sensors still widely used in industrial and other applications. MEMS’ downsized scalability is enabled by the use of micro-mechanical, device-encoded, silicon semi-conductor chips, which allow for the creation of the miniaturized devices and systems now being used in a number of manufacturing settings and applications. (*Editors’ Note—You might want to check out our story on MEMS-enabled desktop factories—“This is About as Lean as it Gets”—in the June 2007 issue of Gear Technology.*)

Peter Adrian is a principal analyst

and research manager in the Tech Insights division of the Frost & Sullivan market research and consulting firm in Palo Alto, CA. He explains how MEMS technology—sensors coupled with electronics that can range in size from a millimeter down to a micrometer—can make an appreciable difference in a manufacturer’s process and bottom line, and in a variety of applications.

“What MEMS technology allows

users with highly developed integration capabilities. Further, according to Tempe, AZ-based Freescale Semiconductor Inc., MEMS functionality can be integrated on the same silicon chip or in the same package, thus reducing dramatically the number of components needed. There are essentially two types of MEMS systems—monolithic integration systems, and a totally self-contained system-in-a-package. The similarity with a distinction between the two is that monolithic integration is a one-die solution using the same silicon, or chip, in which the MEMS device and integrated circuit are packaged together. The system-in-a-package differs in that it utilizes two dies—one for a MEMS device and one for an integrated circuit, both packaged together.

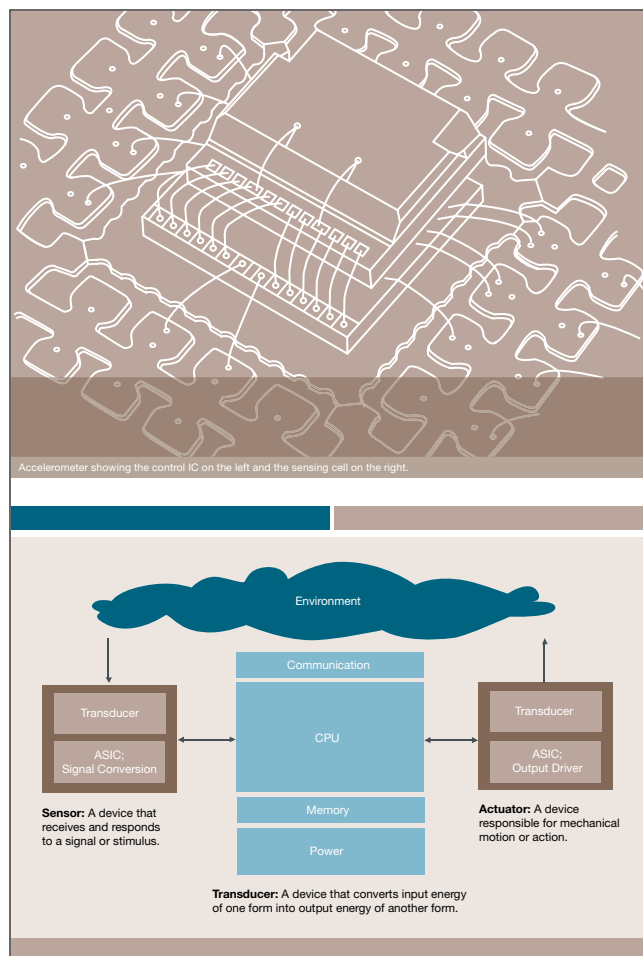
“In an industrial environment, MEMS facilitates using more sensors to monitor different sections of a machine, or to monitor different processes,” says Adrian. “MEMS is conducive to electronically distributed controls, where you can have sensors at many points and they send signals to monitor various parameters and processes.”

In further distinguishing MEMS from the older technology, Adrian explains that older-type sensors are without integrated

electronics, require more real estate, use more energy and that “Their electronic signals can be more difficult to configure,” as well. And, he says, the older sensors are “more expensive.”

And Michelle Kelsey, inertial sensor marketing manager for Freescale, points out that MEMS is also suitable for portable and remote applications, has higher mechanical bandwidths, and

continued



for is the creation of miniaturized devices on a chip,” he says, “so some of the key features of MEMS are small size (miniaturization), lower power consumption, and integration of electronics with sensors. So rather than having bulky external electronics, you can integrate the amplification and signal conditioning with the sensor element.”

Indeed, MEMS technology provides

low thermal mass for faster thermal actuators.

While there are a variety of MEMS-based sensors, it is those that are now being used in the automotive, motion control and power transmission industries that concern us here.

"Accelerometers measure how fast the velocity of an object is changing," says Kelsey. "Initially, inertial sensors were mainly developed to detect shock in order to decide when to deploy airbags. These devices range from 100g to 250g. Sophisticated monitoring devices for other applications are becoming more and more commonplace. Low g inertial sensors that are up to 50g can be used to measure and determine fall, motion, positioning, shock, tilt and vibration.

"For motion control and power transmission—where the position and/or velocity of machines needs to be determined—motion, positioning and

shock detection from an accelerometer can determine the set points of a velocity loop and/or transform the control signal, which is often desired velocity into a higher-power electrical current or voltage for accurate control and automation. This type of monitoring can help in complex motion control processes; a 3-axis accelerometer can report motion using all three axes of orientation of the objects in the system being monitored."

Aside from their micro dimensions, a key attribute in motion control applications is MEMS' ability to provide signals at multiple locations for monitoring of various machines on the floor and processes. MEMS process control pressure sensors and actuators are also widely used in applications for oil and gas; food and beverage; pulp and paper; and in the aerospace sector. Some of the applications relevant to the above include: gyroscopes; gas and flow

sensors; proximity sensors; micropumps and micromotors; microvalves; and microturbines.

For more information:

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Fax: (480) 413-8893
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Zero-Max Shaft Lock Bushings

MEET FDA, ROHS STANDARDS

ETP stainless steel shaft lock bushings from Zero-Max are designed to lock gears, pulleys, sprockets and other components onto a keyless shaft. The bushings contain material that is approved as FDA food grade medium, and they are also RoHS-compliant.

The bushings are designed for use in food, beverage and dairy processing equipment, especially systems requiring frequent wash down. Unlike mechanical bushings that have slots that can trap debris, ETP bushings are completely sealed.

According to the manufacturer's press release, the bushings are easily cleaned and maintenance free. They can handle temperature ranges from -22°F to 180°F .

The ETP Express bushings are designed to provide a tight, solid connection between the shaft and mounted components. The device has a double-walled sleeve filled with the FDA-approved, food-grade actuating pressure medium. When tightened, the single radial screw actuates a piston to compress the medium, thus expanding the bushing walls and creating a solid connection between shaft and component.

This mechanism provides a higher

torque capacity than stainless steel mechanical locking bushings, the release says. ETP Express stainless steel bushings handle torque ranges from 40-1,401 ft.-lbs. and hold concentricity to .0008" T.I.R. They can be used in tight areas and have just one radial-adjusting screw for fast mounting, repositioning and phasing of components to shafts. An Allen wrench is the only tool required to mount and lock these bushings in place.

ETP Express stainless steel bushings are available in inch and metric sizes from 5/8-2" or 15-15 mm.

For more information:

Zero-Max
13200 Sixth Ave. North
Plymouth, MN 55441-5509
Phone: (800) 533-1731
Fax: (763) 546-8260
E-mail: zero-max@zero-max.com
Internet: www.zero-max.com



Nordex

INTRODUCES KNURLED THUMB SCREWS

Nordex Inc. introduced its 303 Stainless Steel Knurled Thumbscrews, which come with a standard-knurled head, a heavy-knurled head or a socket-heavy head (with nylon points supplied upon request). The company has also announced its 300 Series Stainless Steel Thumbscrews with black plastic heads.

In addition to the new items, Nordex carries a line of precision fasteners available from stock, including assortment kits, nuts, pins, retaining rings, set screws, captive screws, machine screws, shoulder screws and threaded stock in both inch and metric sizes.

For more information:

Nordex Inc.
426 Federal Rd.
Brookfield, CT 06804
Phone: (800) 243-0986
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INTORQ Brakes

DESIGNED TO WITHSTAND DAMPNESS, DIRT



A new series of brakes from INTORQ with IP65 enclosure offers a solution for stopping and holding duties in damp or dirty environments. The series BFK461 are spring-applied brakes released by applying DC voltage to an electromagnetic coil.

Brakes can be engaged dynamically at motor speeds and also suit static holding applications.

The BFK461 brakes are constructed with an aluminum casing and O-ring to seal the connection to the mounting surface. A plastic cap and seal close the central bore, and the supplied fixing screws have seals under the heads.

Seven models are available with rated torques ranging from 4-150 Nm. For holding duties, torques can be upgraded to a maximum of 235 Nm. Shaft sizes start at 10 mm and go up to 45 mm. Brake coils can be supplied for 24 V low-voltage connection or rectified mains at 103, 180 and 250 V.

For more information:

Lenze / AC Technology Corp.
630 Douglas St.
Uxbridge, MA 01569
Phone: (508) 278-9100 or
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Internet: www.lenze.com

Techno Inc.

INTRODUCES PHOENIX I SINGLE-AXIS CONTROLLER

Techno Inc. has introduced the Phoenix I servo controller for single-axis automation projects. The Phoenix I includes a servo controller, drive, power supply, enclosure, wiring, cabling and software. The standalone unit does not require a PC to operate, only to program.

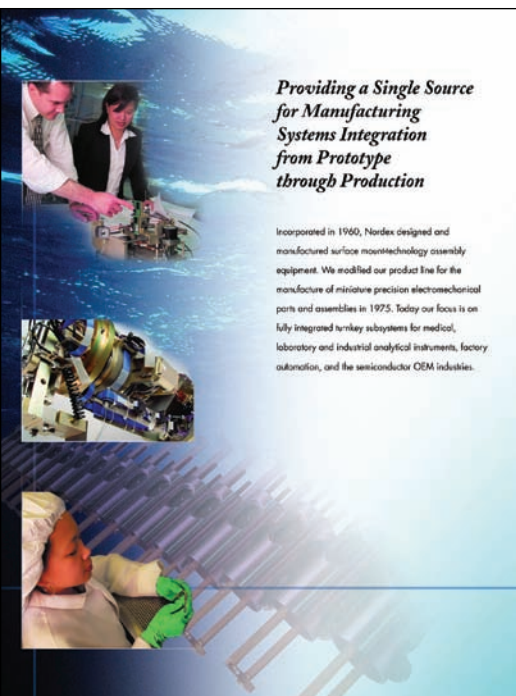
The Phoenix I controls a single belt slide, ball screw or rotary table with servomotor. The job buttons on the front allow for manual positioning without the PC being connected.

The Phoenix single-axis servo controller allows the user to concentrate on their application without sourcing and integrating multiple components from multiple suppliers," says Techno sales manager Joseph Griffin.

The Phoenix I controller comes with a two-line LCD display, and it provides 6 amps of continuous torque (12 amps peak) on a 48 V drive. It comes fully assembled with USB ports for connectivity.

For more information:

Techno Inc.
2101 Jericho Turnpike
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New Hyde Park, NY 11042-5416
Phone: (516) 328-3970
Fax: (516) 358-2576
E-mail: lminfo@techno-isel.com
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Amacoil's Load Platform

RELIEVES RADIAL FORCES ON LINEAR DRIVES

Amacoil offers a linear bearing slide option on drive assemblies to protect rolling ring bearings in Uhing linear drives from undue wear resulting from radial forces.

The linear slide load carrier is recommended when the tool or other payload being moved is mounted so it creates overturning moments, which can interfere with the drive's function and place undesirable pressure on the bearings.

Supported on its own end supports and guide rails, the linear slide redirects twisting and bending forces, removing them from the Uhing drive and assembly. According to Amacoil's press release, this minimizes wear on the drive bearings and other parts. Because linear slide guide rails are parallel with the Uhing drive shaft, linear movement is enhanced, and the possibility of cantilevered or off-center load causing the drive to bind or seize is reduced.

With up to 800 lbs. of axial thrust,

the drives are designed to provide backlash-free linear motion in packaging and converting equipment, winding machines, spraying/coating systems and other automated industrial machinery.

Three styles are available to accommodate different payload mounting methods and varying weights. The standard linear slide model SLS and the L2 for heavy-duty loads are mounted on top of the Uhing drive. A third model, the L4, mounts to the back of the Uhing drive. A load-supporting surface on the L4 slide extends above the top of the drive by 1–2 mm for situations where a slide is needed but vertical space is limited.

Finally, the load carriers are flexibly coupled to the Uhing drive unit with no rigid connection. This assures that overturning moments and other forces created by the payload do not work against the axial thrust.

For more information:

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Aston, PA 19014
Phone: (610) 485-8300
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TB Wood's

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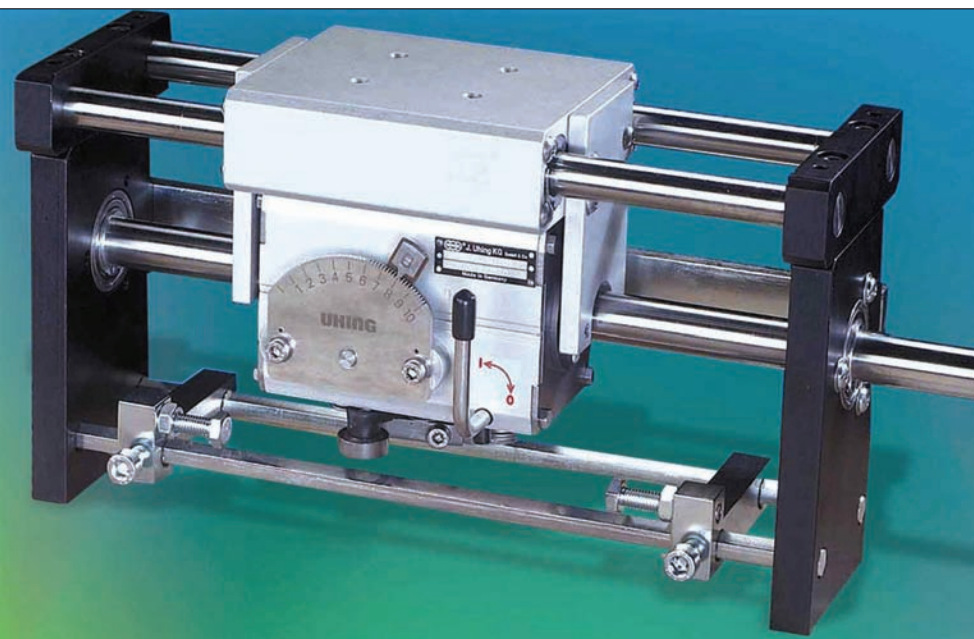


The new X5 UltraFlex AC Drive from TB Wood's augments the company's line of enclosed, variable-speed AC drive products.

According to the company's press release, the new drive offers the same rugged construction, versatile programming and horsepower range (up to 200 hp) as its X4 Drive, as well as advanced features, including a real-time clock, support for most popular communication protocols, encoder feedback capabilities and a USB port.

For more information:

TB Wood's Inc.
440 North Fifth Ave.
Chambersburg, PA 17201
Phone: (888) 829-6637
Fax: (717) 264-6420
Internet: www.tbwoods.com



New Allegro Switching Regulators

REDUCE ENERGY USE

Allegro MicroSystems introduced a new family of switching regulators with high operating frequencies and external components. This new series of devices addresses a market need for increased energy-saving electric and electronic equipment targeted toward the portable and office automation markets.

The SI-8000T (1.5 A) and SI-8000F (3.5 A) series have reduced die sizes, between 62% and 84% of the previous generation of devices for the same current levels, the SI-8000J and SI-8000S series, respectively. Also, the SI-8000H (5.5 A) series breaks new ground, offering a line-up that exceeds 5 A.

By connecting an open collector transistor, the user is able to set an on/off control for output voltage. Moreover, many of these devices offer a soft-start option that is set by an external capacitor at pin 5.

All devices within this series provide UVLO (under-voltage lock out) protection to avoid abnormal IC operation when the input voltage is less than the minimum operating level. Auto-regression OCP and OTP protection is also built in. The reduction of die size improves IC response speed,

making higher oscillation frequencies attainable. The SI-8000T/F operates at 300 kHz, the SI-8000H at 150 kHz, the SI-8000J at 125 kHz, and the SI-8000S at 60 kHz.

For more information:

Allegro Microsystems
 Phone: (508) ALLEGRO
 Fax: (508) 853-3353
 E-mail: sfennelly@allegromicro.com
 Internet: www.allegromicro.com



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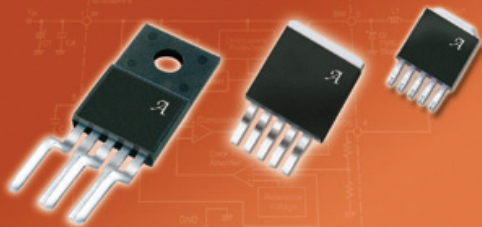
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Belden

OFFERS DOD-QUALIFIED PARTS LISTING U-JOINTS

Belden's line of universal joints and drive shaft assemblies includes a range of Qualified Parts Listing (QPL) universal joints for government procurement and use in military personnel carriers, multi-role vehicles and aerospace applications. The QPL universal joints are designed and manufactured for a variety of applications, including high lift actuation and control mechanisms for aircraft where low deflection rates, high strength-to-weight ratios and long service life are essential.

The "approved brands list"—or Qualified Parts List—is a list of products that have successfully completed the formal qualification process that examines, tests and verifies that the product meets all the applicable requirements.

Belden's MS 271 Series Military Standard universal joints have successfully undergone the qualification and acceptance testing, according to Belden's press release. Stork-Herron Testing Labs performed incoming examination of MS Series joints supplied by Belden. The examination included verification of materials, construction, dimensions and identification of

products. The joints were certified to the requirements outlined in military specification MIL-DTL-6193D and accepted by the U.S. Department of Defense.

To qualify the universal joints, a variety of extensive and rigorous testing was completed to assess the mechanical performance of the joints. Reaction frames were designed and fabricated to perform torsional play, tightness, static torque, endurance and lubrication retention testing. The universal joints were also tested and certified for design and construction, which includes dimensions, assembly, hardness, finish and lubrication-retaining covers.

The Belden Military Standard universal joint is designed to withstand the most demanding operating conditions and harsh working environments with little maintenance in the field. The MS design is also widely used in Formula One and NASCAR racing.

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Phone: (708) 344-4600
Fax: (708) 344-0245
E-mail: info@beldenuniversal.com
Internet: www.beldenuniversal.com



Omron's STI Modules

AVAILABLE WITH AC VOLTAGE INPUT



The RM-2AC-IP is the latest addition to Omron Scientific Technologies Inc.'s RM-2 family of resource modules. Three models are now available for DC or AC input power for operation in a variety of environments.

The new RM-2AC-IP features IP65 protection with a rugged metal chassis for harsh applications. The RM-2 features an IP20-rated 100 mm DIN enclosure, while the RM-2AC features an IP20-rated 150 mm DIN enclosure.

RM-2 resource modules provide a centralized location for all connections and convert the output of those devices to force-guided relay outputs. The RM-2AC and RM-2AC-IP include a power supply and pair of safety relays, making them a suitable companion and a single point for wiring Omron STI's MS4800, MS4600, OF4600, PA4600, F3SJ and OS3101 safety devices. These resource modules provide connection points for all safety device functions and serve as a central point for terminating all signals to and from a safety device, including external device monitoring.

Two N/O safety relay outputs and two N/C auxiliary relay outputs are provided, and, depending on the load rating of the device being switched by the relay contacts, these force-guided safety relay outputs can be used for external device monitoring. Removable terminal blocks facilitate installation and servicing.

For more information:

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Fremont, CA 94555
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Fax: (510) 744-1442
E-mail: sales@sti.com
Internet: www.sti.com

REDEX

OFFERS HIGHLY RIGID PLANETARY REDUCERS

The REDEX SRP series of planetary reducers from Andantex USA is designed for demanding applications. Combining several pre-assembled functions to provide a complete sub-assembly, the SRP reducers offer overall rigidity that is 10–20% higher than market standards, the manufacturer says.

The SRP reducers are designed for compactness and can be used to control dynamic movements on all types of robots, machine tools or special machines. The reducers can be used for rotation (robot arms, indexing tables, tool changers, etc.) or translation (precision rack and pinion drives).

The SRP reducers provide angular backlash of about one arc minute. The input interface is available in an in-line flange version or with a 90° angle.

The reducers feature oversized conical bearings on the output. The design of the casing/outer ring assembly enables the use of larger bearings than

those fitted by competitors for the same unit size, the company's press release says. The SRP is thus able to provide higher torsional rigidity than other models on the market.

The planetary gears also provide increased rigidity and very low levels

of angular backlash, along with high efficiency and mass torque, according to the release.

The SRP reducers can be equipped with a range of flange-mounted or shaft-mounted motor interfaces. An angle drive is available as an option. Available

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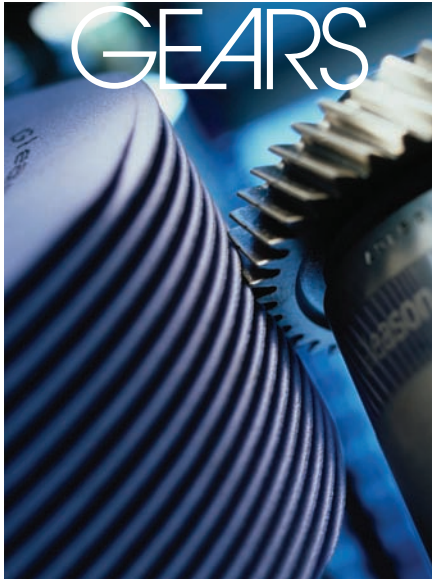


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Automation Direct has introduced the HPS Imperator series of Hammond control transformers.

The HPS Imperator series is designed for high-inrush applications requiring reliable output voltage stability, including industrial applications in which electromagnetic devices such as relays and solenoids are used.

The transformers are 50/60 Hz, 600 V class, machine tool rated, with ratings from 50 VA up to 1,000 VA. They are UL listed, CE marked and RoHS compliant. Finger-safe terminal covers and primary-side fuse kits are available. Prices range from \$31–\$141, and the HPS Imperator transformers carry a lifetime warranty.

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SKF's Miniature Ball Screws

DESIGNED FOR POWER HAND TOOLS

SKF miniature ball screws feature internal recirculation inserts promoting smooth-running performance and backdriving characteristics, serving in a wide range of portable and hand-driven tools for cutting, drilling, riveting and forming operations, among others. Their design includes cylindrical nuts with a threaded end for easy mounting and optimized nut geometry. Designed to be less sensitive to misalignment, these ball screws provide repeatability and operate at reduced noise levels, compared with conventional tube-design types, according to SKF's press release.

Diameters of these "SD Series" miniature ball screws range from 8–16 mm; leads range from 2–5 mm; and screw shaft lengths are available in sizes up to 2,100 mm. Options include safety wire devices, wipers and corrosion-resistant materials.

Nuts with two to six circuits can be ordered. All ball screw assemblies can be integrated with accessories for screw shafts and nuts and supplied with necessary support bearing packages pre-assembled.

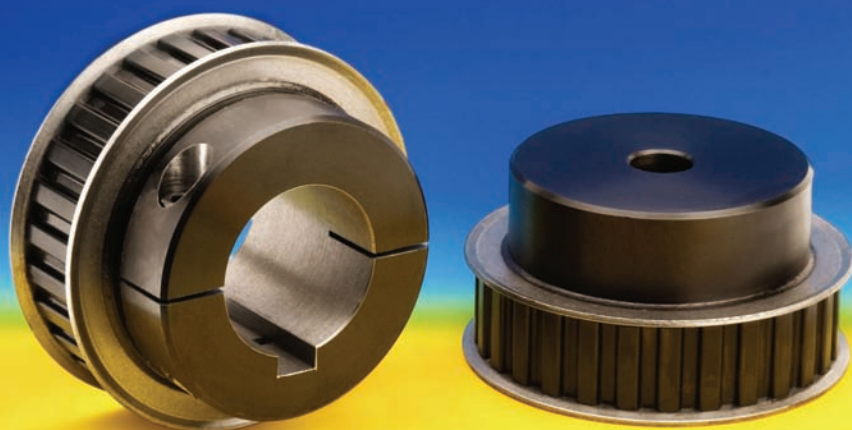
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Stafford Hub Treatment Service

IMPROVES CUSTOMER COMPONENTS



Stafford Manufacturing Corp. is offering a new service to convert plain hubs on drive components into integral, non-marring clamps which fit more securely, prevent damage to shafts, are easier to reposition and provide greater vibration resistance, according to the manufacturer's press release.

Stafford's Hub Treatment Service converts a plain hub on virtually any drive into an integral clamp that can be bored to size and finished with or without a keyway. The process is designed to create a hub which evenly distributes clamping power and fits squarely.

This treatment provides greater vibration resistance than a set-screw and easier repositioning, the release says.

The hub treatment is machined into customer-supplied drive components. The integral clamp, or AccuClamp feature, retains the integrity of the hub and integrates a self-centering clamping collar, which is secured using two socket cap screws.

The service is priced according to the drive component configuration and quantity.

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DESIGNED FOR
MACHINE TOOLS

R+W Servomax EK6 couplings have a chemically stable elastomer insert that is press-fit between two precision-machined coupling halves. According to the manufacturer, this gives the coupling zero backlash and guaranteed concentricity.

The hubs are mounted onto the shaft using conical bushings, and the two components are mated together during installation of the motor.

The high clamping force, concentricity and zero backlash make the EK6 applicable for machine tool spindles, which often operate at high speeds with very rapid accelerations. The elastomer insert also helps mitigate shock loads as cutting tools meet interference from the workpiece, R+W's press release says.

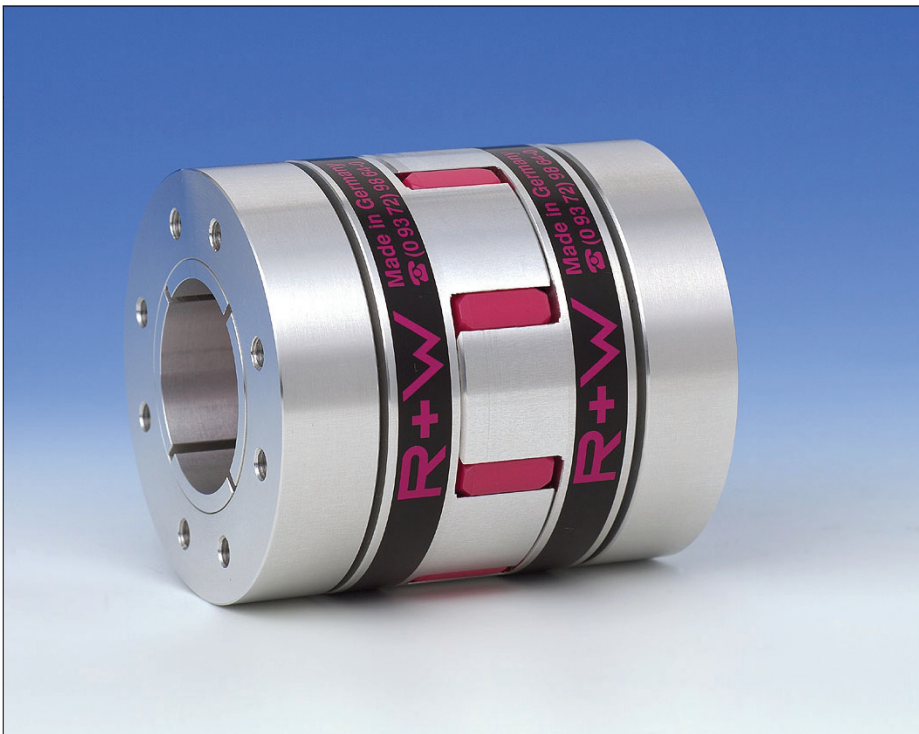
A positive stop on the conical ring is unique to R+W, the release continues,

allowing for assurance of tightening to the correct torque during installation. This feature is designed with high-speed applications in mind, and it also makes the coupling easier to remove as a result.

The elastomer is available in four Shore hardnesses, depending on the level of vibration damping or torsional stiffness required. Bore diameters are available from 6–80 mm (1/4–3.125"). Sizes are available for torque capacities ranging from 10–2,150 Nm (88.5–54,610 in.-lbs.).

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Portescap Ironless Brushes

IMPROVE EFFICIENCY
IN DC MOTORS



Portescap's 25 mm brushed ironless DC motors feature a carbon brush commutation method for increased efficiency in high-volume manufacturing applications.

"Unlike the axial spring commutation configuration common to most brush DC motors, the 25 mm brushed ironless DC motors offer a rotational spring that delivers constant spring force, extending brush life and minimizing motor sensitivity to vibration shocks," says Udayan Senapati, Portescap's product line manager.

According to Portescap's press release, the new commutation method, coupled with a metallic front end and optional integrated EMC filter, make the 25 mm brushed ironless DC motors suitable for operation in semi-conductor wafer handling and metrology and industrial equipment applications. Additionally, its power-to-size ratio is suitable for power hand tool applications.

Two versions are available, both 25 mm in diameter. The 25G is 53 mm in length, weighs 145 grams and provides 40 watts of power with 40 mNm continuous torque. The 25GST is 43 mm in length, weighs 111 grams and delivers 27 watts of power with 30 mNm continuous torque.

For more information:

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IMI High-Frequency Sensors

DETECT VIBRATION PROBLEMS

The model 621B40 high-frequency industrial ICP accelerometer from the IMI Sensors division of PCB Piezotronics works with online or portable monitoring systems to provide vibration monitoring.

According to the manufacturer's press release, the 621B40 operates to 30 kHz, even with a magnet, and captures high frequency gear mesh faults often missed during routine route-based measurements. The sensor's high frequency range is designed for measurements on high-speed compressors, gearboxes and turbomachinery for early detection of impending problems.

When analyzing the condition of an integral gear compressor, a technician must be able to examine gear mesh frequency and its sidebands. The

harmonics of the gear mesh and natural frequency of the gears play a significant role in diagnosing potential machinery faults. A magnetically mounted Model 621B40 supplies a response to more than 30 kHz, allowing a vibration analyst to obtain precise measurements of these high-frequency phenomena.

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Prime Advantage Corp. Provides Purchasing Clout and More

Jack McGuinn, senior editor

A little over 10 years ago, Louise O'Sullivan was serving as president of one of Dover Corp.'s myriad divisions. One of her duties in that role was to attend the bi-annual cattle calls, i.e.—corporate executive business meetings attended by approximately 22 Dover decision makers. Invariably, at some point in those meetings, someone would ask, “Since we all buy the same things, why don't we pool our significant purchasing power to achieve better pricing and service?” As if on cue, everyone in the room would promptly salute the idea,



Louise O'Sullivan, Prime Advantage Group president.

and then head back to their respective companies at meeting's end.

“Everyone thought it was a great idea,” says O'Sullivan, “But then we'd all go back to our respective jobs and hope that someone was working on that.”

Corporate bureaucracy being what it is, no such luck.

“So 10 years ago,” says O'Sullivan, “I said to a number of the Dover companies, ‘Listen, we really have opportunities to pool our purchasing, to leverage our spends, aggregate our demands, and to really have more clout with our suppliers. If I start a business, will you, first of all, join and pledge your purchases, and secondly, will you help us bring in new suppliers?’

“Starting Prime Advantage was a chicken-and-egg scenario,” she explains. “You had to have the members to have the suppliers and, obviously, vice versa.”

It turned out that O'Sullivan won over sufficient hearts and minds that day. Now, Chicago-based Prime Advantage Corp., a private, for-profit buying group comprised of some 280 member companies, provides for its members pre-negotiated discounts and rebates from over 115 PrimeAd-endorsed suppliers. Other significant benefits include negotiated volume discounts and rebates

for raw materials, components, supplies and services.

“We started with 13 visionary companies, and half of them were Dover companies,” says O'Sullivan.

Of particular interest to PTE readers, included in the mix are member suppliers in the power transmission and motion control industries who benefit as both sellers and buyers. On the selling side, supplier members are presented to an array of would-be senior buyers; on the buying end, those same suppliers—of bearings, for example—realize savings on raw material metals.

A look at Prime Ad's supplier roster shows a number of manufacturers and suppliers of bearings, electric motors, valves and pumps, internal gears, plastics, controls, hydraulics and various metals used in the power transmission and motion control arenas.

Slackers need not apply. There are a number of requirements to qualify for membership, and they are etched in stone. In essence, those requirements are what make the group viable and of legitimate value to its members.

Says O'Sullivan, “You have to be an OEM; you have to purchase a specific minimum of product through the Prime Advantage suppliers; you have to

agree to attend two conferences per year, which are individual one-on-one meetings with buyers and which provide a lot of purchasing education; and you have to agree to give our suppliers every opportunity to quote your business. But they still have to earn it.”

Indeed, O’Sullivan points out that potential suppliers undergo a “rigorous” vetting process before securing “endorsed supplier” status. O’Sullivan says the group seeks out and recruits Tier 1-caliber global suppliers, and strives to have at least two or three of them for each member’s business category. Much of the initial work is done by an internal supplier development team, which looks at and screens suppliers. And that’s only the beginning.

“We have an 18-page supplier selection document that they have to fill out, which rates them on 12 different categories,” O’Sullivan says. Then, after being nominated by a group member, “They give themselves a rating and then the nominating member gives them a rating. And that’s probably the most important key; they must be nominated by a member in order to become an endorsed supplier. So you can imagine members are only going to nominate their superstar (suppliers) because they don’t want to hang their hat on somebody that’s not terrific.”

There’s more.

“After that, there’s a supplier selection committee that the suppliers make their proposals to, and that commission is comprised of 22 members. And if they like the proposal, like the company, see that the pricing is competitive, and if (the applicants) are truly what they say they are—top-notch, global, meet all the requirements—then it goes to the executive board, which is another seven member companies, and they actually make the endorsements.”

O’Sullivan adds that even endorsed suppliers are also subject to a twice-yearly, online review system—the Prime Advantage Supplier Evaluation (PASE)—in which they are rated by all members that have bought from them. She describes it as an “early warning system” that helps identify supplier

problems before they get out of hand. Conversely, the suppliers have access to the evaluations as well, providing them with a snapshot of how they are perceived by member customers.

Strength in numbers. Requirements with teeth aside, O’Sullivan says there is a waiting list. That is probably due at least in part to the group’s efforts to protect existing supplier members by keeping at three the number of suppliers for a given category.

Another way that a member supplier can benefit is by becoming an associate member. That upgrade in status provides them with the same buying price breaks that other members enjoy. They are al-

lowed to buy from fellow supplier members and in turn realize the same volume pricing and other rebates. For example, says O’Sullivan, a metal supplier member may wish to purchase material from a member strapping or roofing supplier, which helps boost the group’s volume buying—and selling—power. It’s a synergy upon member supplier and buyer loyalty that benefits all.

“We say to suppliers, if you give us a very aggressive rebate, and you stay in the top quality segment of your market, then we will ensure that our business model of two to three (suppliers) per category will keep you very much in the forefront,” O’Sullivan explains.

continued



Members are strongly encouraged to serve on PrimeAd’s various committees. The groups meet throughout the year to help advance new ideas regarding sourcing and sales issues.



Table discussions at Prime Advantage conferences are a perfect meet-and-greet venue for members.

Prime Advantage members are typically mid-sized, says O'Sullivan, who points out that the self-imposed minimum buying requirements may preclude most smaller companies from admission.

"Our smallest members are at around \$20 million (in sales); our largest members are around \$3 billion," says O'Sullivan. "Our sweet spot is probably around an average of \$100 to \$200 million, but we still have a lot of large members with de-centralized companies and we have a number of smaller ones."

Information is power. As for the required-attendance learning opportunities mentioned earlier, they include two conferences yearly, which, says O'Sullivan, "are probably the glue that makes this group work so well, because they're one-on-one meetings over two-and-a-half days where suppliers can meet with 200 companies on one plane ticket, and members can have two days of uninterrupted, strategic sourcing. The members can go online and select with whom they'd like to meet, and the suppliers do the same. So the suppliers each take a (hotel suite) and then the members move from suite to suite. We choreograph everything."

There are also two additional educational sessions per year, a fall summit conference at which speakers talk about

such things as leadership, strategy and managing change, for example. In the spring, the focus is on the technical side, says O'Sullivan. Engineers are invited to expound on leading-edge design and technologies relevant to the members.

Marketed for success. Along with everything else, Prime Advantage works closely with both buyer and supplier members on their marketing efforts. Prime Ad account managers are assigned to members in order to work closely with them in providing strategic direction and sourcing, some to the extent that they actually maintain a desk onsite. With buyers and sellers, says O'Sullivan, the account managers in effect wear two hats.


"When they work with our buying members, they become an extension of their purchasing team. Because what they do is shorten the (supplier) search and help hone in on members' pain points—Where are you feeling the most pain? What are your strongest needs? What are your hottest buttons? Where are your costs possibly the most excessive? and, Let's get together with a plan to reduce those and then let us help you with your sourcing."

Conversely, says O'Sullivan, "When (the account managers) are wearing the supplier hat—when they're an extension of the supplier's sales team—what

they're also doing is shortening the dance. They're leading the supplier to the exact (buyer) member who says, "This is my pain point."

As for Prime Advantage's future, O'Sullivan sees the glass as half full and envisions a global reach at some point.

"We don't see ourselves topping out at all," she says. "There are many, many manufacturers out there that don't have the advantage of leverage. Ask any company—If you had more volume, could you get a better price?—and it's hard for them to say no."

"Our growth is going to come from bringing on new suppliers, new members. Our group buys about \$1 billion in metals today, so what's the next high-growth area that might be a new vertical for us? Whether it's plastics, or rubber, or some other technology—that's a possibility. But we can also see ourselves growing horizontally because the more suppliers we have that are top-notch, the greater the opportunity it's going to give us to go internationally." 

Editor's Note: Visit PTE.COM for a sidebar to this story including two members' reactions regarding Prime Advantage Group's benefits to their companies.

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Tom Tetlow, vice president of Enodis PLC, addresses Prime Advantage members at the semi-annual Purchasing Network breakfast. His topic—maximizing supplier evaluation systems.

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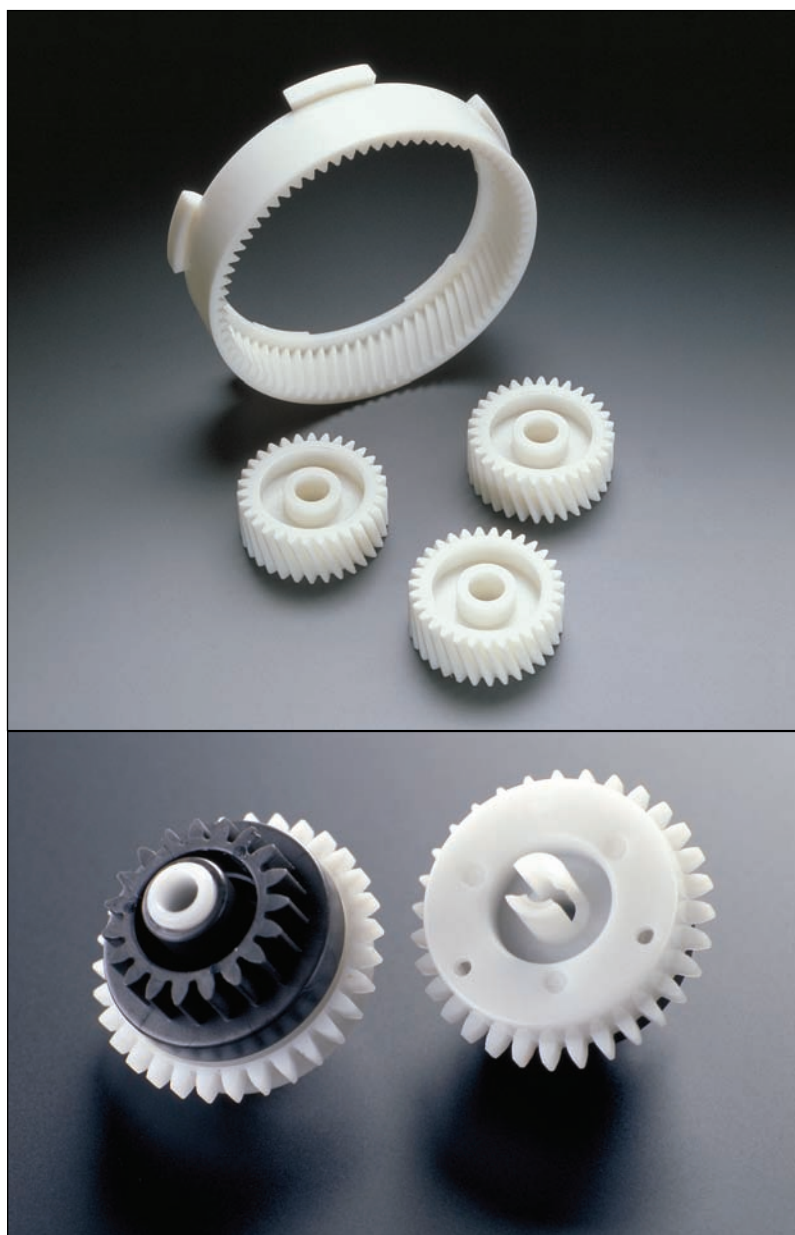
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Processing and the Design of Precision Plastic Gears

Zan Smith and Dave Sheridan



Some gear geometries are more practical to produce than others. Since choices made early in the design process affect the ease and cost of fabrication, those who design gears would do well to consider molding and how molders operate, especially when they create precision gears.

Gears intended to maximize power and minimize transmission error can push tooling and processing equipment and the methods and plastics used to their limit. The same is true of designs for quieter drives, longer-lived gears or smaller gearboxes that retain the power of larger ones. The type of gear fabrication also affects molding operations.

Although plastic spur gears are usually produced in a straightforward injection molding process, as precision rises they demand more advanced tool-building skills to meet criteria for concentricity, tooth geometry and other features. Weld line considerations also become more significant with greater precision, especially when fiber-reinforced resins are used. Similar considerations apply to other gears, such as face gears and those having eccentric shaft locations and variable pitch surfaces.

Designs for plastic helical gears call for complex tool movements to aid in ejection. The tool must also account for differential shrinkage, such as in the axial versus radial dimensions. Part ejection is also an issue with internal

gears and crowned gears. Tooling for internal gears may need ejector rings, floating cores and other mechanisms so parts can be removed from the core on which they form after a plastic shrinks upon cooling. The variable tooth profile in crowned gears and enveloping worm wheels has driven processors to devise proprietary methods to ensure their removal.

A Brief Look at Plastics in Gears. The polymer chosen affects fabrication. For instance, those that shrink relatively little in molding, such as liquid crystal polymer (LCP), make it easier to design tools for high-precision gears. The nature of the material also affects many molding parameters, such as the temperature and pressure used, mold filling speed, cooling time and mold release.

Plastics give gear designers many cost, design, processing and performance advantages compared to metal. Plastics can form gears that are hard to create at a reasonable price in metal, such as internal and cluster gears. They usually need fewer fabrication and assembly steps and are more forgiving because they deflect to absorb geometric irregularities and impact loads. Many have an inherent lubricity that makes them ideal for dry-running, low-load gears. In addition, they often resist water and many chemicals better than metal.

Acetal, polyester and nylon are the most common gear plastics. They process well and form gear sets with good fatigue and wear resistance, lubricity, rigidity and toughness. These and other engineering polymers tolerate elevated temperatures (Fig. 1). Unfilled acetal copolymer works to about 115°C, unfilled polybutylene terephthalate (PBT) and nylon 6/6 to about 150°C, glass-filled PBT and nylon 6/6 to about 170°C, polyphenylene sulfide (PPS) and liquid crystal polymer to about 220°C. High-temperature nylons and polyphthalamide have somewhat lower thermal limits than PPS, while imides and polyetheretherketone (PEEK) have higher limits.

Acetal, a primary gear material for over 40 years, offers dimensional stability, fatigue resistance, and good chemical

resistance and lubricity. PBT works well in gear sets having gears made of other plastics and metal and yields smooth surfaces in molding. Nylons offer exceptional toughness and wear, but their dimensions are subject to change when they absorb water and many lubricants. As a result, they are not usually used when precision is needed.

Polyphenylene sulfide is stiff and dimensionally stable in molding and offers good fatigue life and chemical resistance. It is often the material of choice for drives in hot, corrosive industrial and automotive environments. Liquid crystal polymer flows exceptionally well to fill intricate, thin-walled parts with great accuracy and works well in small, lightly loaded gears. It withstands temperatures to 220°C and has low mold shrinkage. PEEK is often used in specialty, higher-temperature applications.

The call for quieter gears and low-wear, dry gears has led to greater use of flexible polymers and those having inherent lubricity. Elastomers, like polyester elastomer, help lower-power, lower-load gears run quieter. Lubricious polymers, like acetal copolymer, often enhanced by low-friction additives like a fluoropolymer or silicone, create gears low in wear and noise.

Fibers and fillers improve a resin's mechanical properties, especially stiff-

ness, and let designers fine tune a material to a specific gear application. This is especially true of long fiber-reinforced plastics that can give large gears greater strength and dimensional stability. They also allow the use of less costly polymers; e.g., polypropylene reinforced by long fibers can provide better strength and stability at a lower cost than short-fiber-reinforced nylon. Flow direction in the mold and weld lines and other flow-related features become more important when fibers are present. Proper tool and processing conditions are critical for maintaining fiber length and mechanical properties. Also, with fiber present, weld lines can severely affect gear quality.

Processing Precision Gears. Molders face common challenges in fabricating precision gears. They need to hold exacting dimensions between the hub and the teeth, keep warpage at bay, maintain gear uniformity from shot to shot and cavity to cavity, and much more. These requirements affect all levels of fabrication, from tooling and molding equipment to work procedures and molding environment. Molding operations should strive for a wide and stable processing window that gives optimal material properties during prototyping and the early stages of production.

Tooling for precision gears calls for

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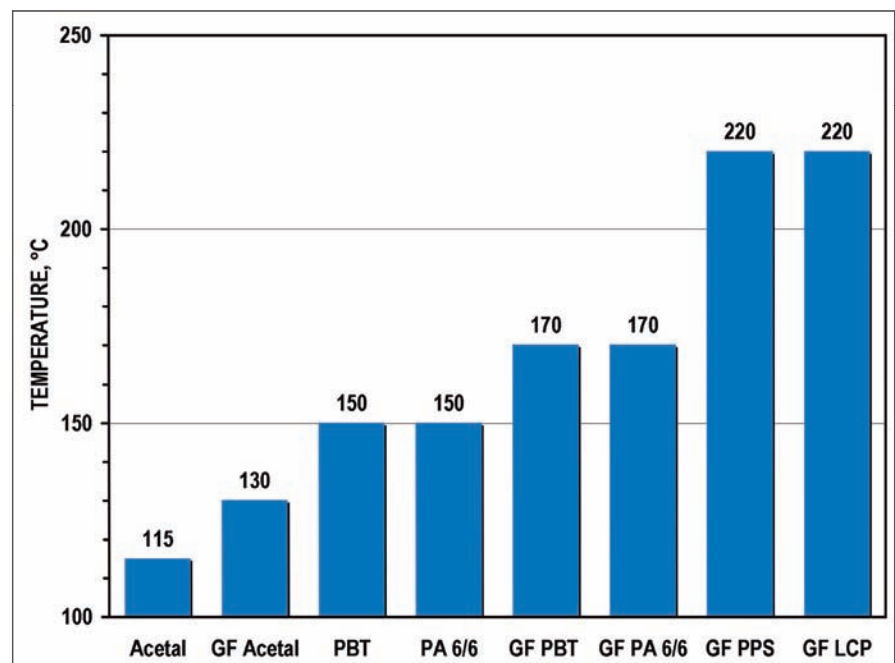


Figure 1—Upper-temperature limits for selected plastics and gears.

great attention to detail and often demands accuracies approaching that of gauge making. Plastic gears are routinely molded to AGMA Q7–Q9 standards and many are made to Q10–Q12 specifications. Designers should use only the precision level needed, since cost rises sharply with precision. A jump of two accuracy levels halves the allowable variation, which demands more sophisticated tooling and molding equipment and procedures, requires more involved

inspection procedures, and other steps. A common tooling issue for precision gears is the ability to cool symmetrically across a gear and uniformly in different cavities. The need to control cooling generally leads tool builders to keep the number of cavities in a tool to four or less for such gears. The mold cavity must be scaled so the gears shrink to the proper size. Spur gears usually call for straightforward split-cavity molds, while other

gears may need special movements so they can be removed from the mold. Helical gears, for instance, often need a tool that lets either the gear or the gear ring forming the teeth to rotate during ejection. With worms, ejection can also be done by unscrewing them from a cavity or by using multiple slides. Tool builders should minimize parting lines on the teeth when slides are used.

Controlling the flow in the mold when fibers are present is important for limiting weld lines and minimizing anisotropic shrinkage. Spur gears made with a neat resin can be filled from two or more gates. Fiber-reinforced polymers are best filled by a single gate at the center of the gear to avoid weld lines that form when multiple flow fronts meet (Figs. 2 and 3). Weld lines can affect tolerances as fibers align radially along a knit line and cause “run-out bumps.”

In general, the higher the quality level, the less complex a tool should be. The use of multiple pulls, slides and other mechanisms can make it hard to retain precision because each action adds a variable. As a rule of thumb, the process should not give up more than a third of the accuracy requirement to the tool.

There are cases, however, when special mechanisms make a lot of sense. Adding inserts for teeth can reduce recutting costs when adjusting a tool during development. Inserts also reduce retooling costs as a mold wears because only the inserts need to be changed out and not the entire tool. Also, each tooth of a coarse pitch gear may be cored out to avoid the presence of substantial masses of plastic that distort as they cool (Fig. 4). The thinner walls gained in coring also shorten cooling time. While such cores make tools significantly more complex, the economies gained through faster cycle time can more than offset their cost.

Processors should ensure that imperfections caused by tools, such as gate vestiges, ejector marks and parting lines, as well as those that occur in molding, such as flash, flow lines and weld lines, appear in nonfunctional areas of the part so they do not affect gear function

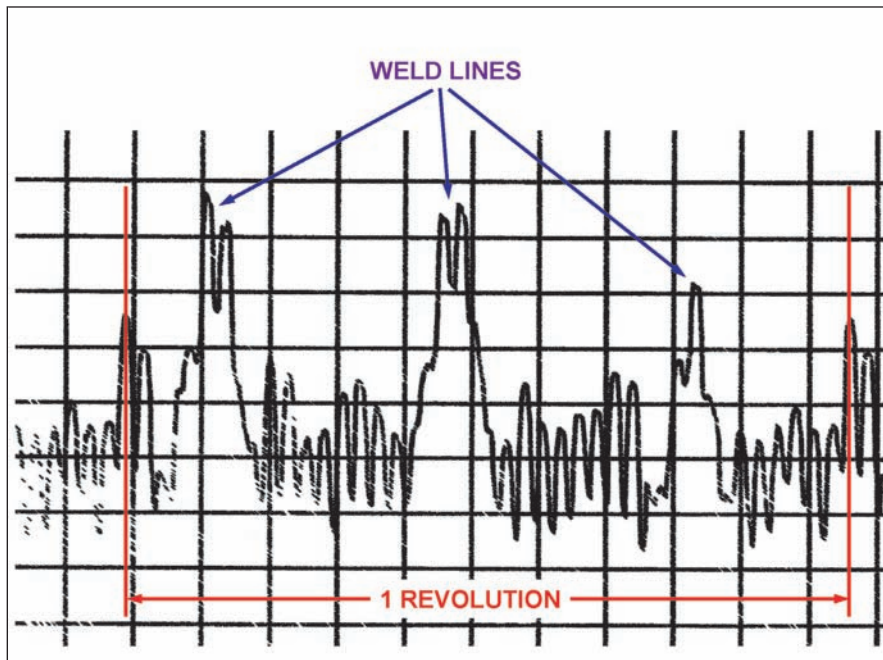


Figure 2—Double-flank roll checker composite measurement showing effect of three symmetrical, radial-weld lines (the three highest peaks) on a glass-reinforced gear.

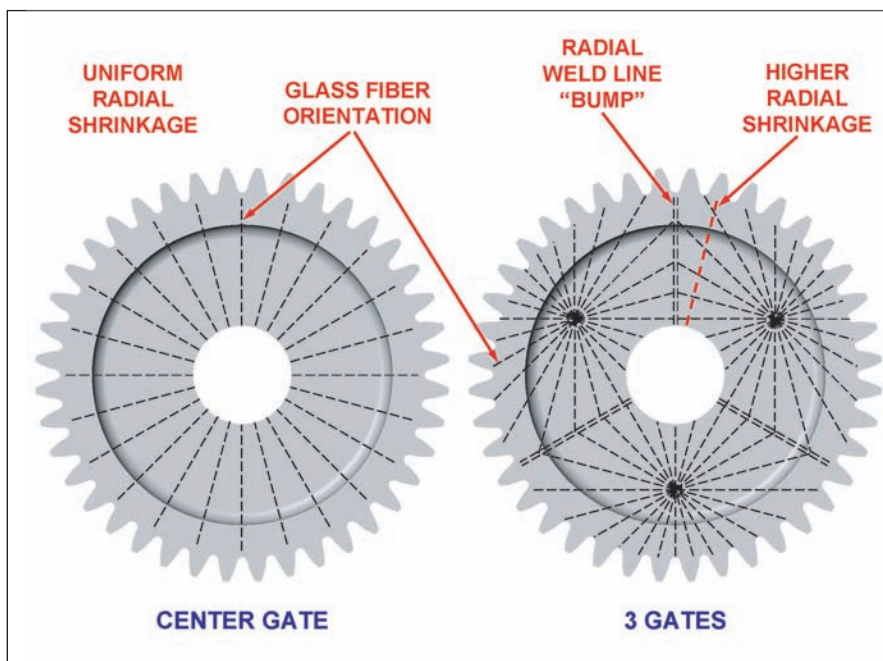


Figure 3—Glass-fiber orientation with center- and three-gate tools.

or quality.

Molding Operations. Molding is a holistic endeavor that begins with good part and tool design and extends to the molding equipment, polymer and the processing conditions used. Those who mold precision gears need advanced molding equipment equipped with the latest process controls that hold mold temperature, injection pressure, cooling and other variables within a tight window. Some gear processors go a step further and add pressure and temperature sensors in mold cavities to improve consistency and repeatability.

There is also a need to attend to all variables that can affect the process. The ability to make gears as uniform as possible time and again requires a focus on operating procedures and proper training. How workers act is often the deciding factor in producing precision gears. The goal is consistency at every step—from the initial receipt of a resin to packaging and storing the finished gear.

Molders of precision gears also need solid environmental controls. Gear dimensions can be affected as air temperature shifts with the seasons, or even for a few hours if an outside bay is left open. To remedy this, processors may place their equipment in closed cells, especially those elements concerned with cooling a part after it is removed from a mold. Processors often strive to provide airflow over hot gears and use consistent gear placement during cooling. Some shops remove gears from molds via robotics and place them on conveyors the same way every time so cooling is uniform.

Consistency extends to many other areas. Molding operations for precision gears should use dedicated equipment, a stable power supply and drying equipment that gives the polymer feed the same temperature and moisture level in all runs. If regrind is used, it should be clean, free of fines, dried properly to eliminate trapped moisture and added to the virgin material in consistent proportions.

Quality control inspections should occur at the same time after fabrication.

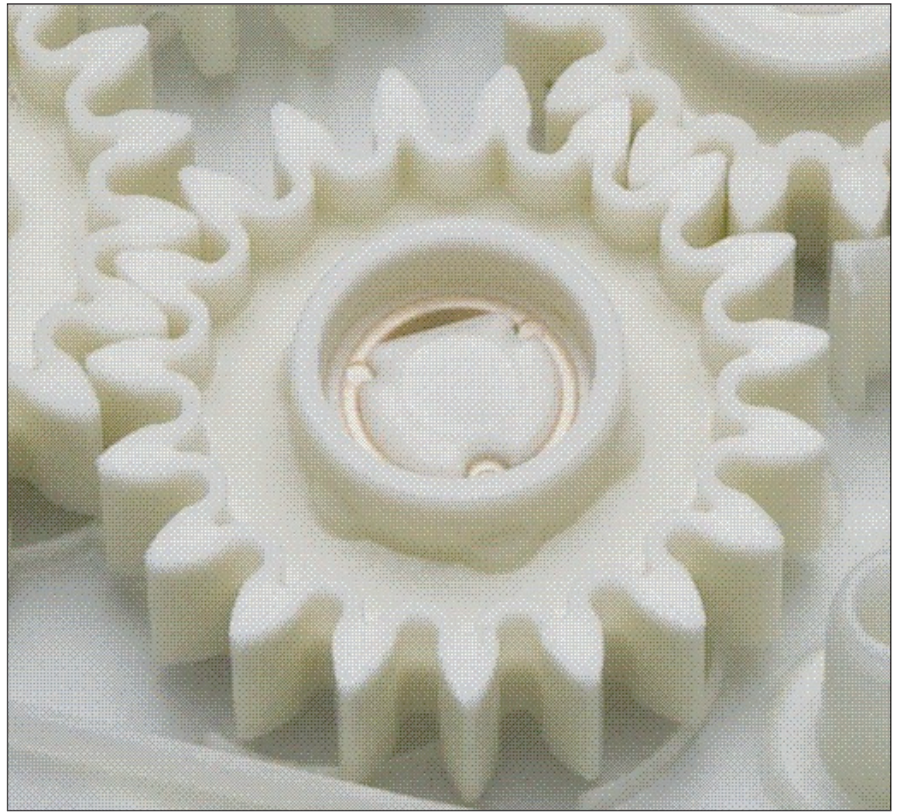


Figure 4—Coring out coarse pitch gears reduces processing time, weight and cost, and improves gear dimensional integrity.


Part weight is used to gauge the consistency and repeatability of the molding process. Production gear checking usually involves double-flank roll checkers, which give a composite measure of tooth thickness, runout and other features. Elemental inspection is often used when building and fine tuning precision tools and in prototyping to identify the cause of an error. Additional gear production quality control instruments include calipers and other standard hand tools.

Conclusion

The market for precision plastic gears is expanding in many directions, given the demand for gears that are quieter, more powerful and more accurate. While it is tempting to adopt elaborate solutions to meet gear design challenges, the ramifications for tool complexity and molding practices should be factored into the design process. In other words, those involved in the front end should keep the back end in mind by understanding the molding process and its inherent options and limitations.

This is best done in collaboration with a resin supplier, a tool builder and a molder early in the design process to

help evaluate the processing aspects of different gear solutions. Such input can eliminate many production missteps and the extra cost and time lost in reworking a design that does not process well.

Designers who are knowledgeable about molding close-tolerance gears can also play a role in selecting a processor that offers the needed high-performance molding machines, procedures and environment to ensure gear consistency and repeatability. 

Zan Smith is a senior staff engineer at Ticona Technical Polymers and that company's technology leader for gears. He has been involved in the development of plastic gears and gear materials for more than 25 years. He earned his PhD from No. Carolina State University and is a past board member of AGMA.

Dave Sheridan is a senior design engineer at Ticona Technical Polymers and has been involved with the design of plastic gears for many applications for the past decade. He currently serves as a member of AGMA's plastic gear standards committee. He holds a BS in mechanical engineering from Kettering Institute in 1988.



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AGMA

The Gear Industry's Learning Center and Resource

Readers of our sister publication, Gear Technology, are perhaps more familiar with the American Gear Manufacturers Association (AGMA) than our PTE audience. Now more than 90 years old, AGMA continues to thrive as a global, relevant go-to resource and service provider—from metrology to tribology—for its more than 400 worldwide members. PTE put some questions regarding AGMA—now, and going forward—to AGMA president Joe T. Franklin, Jr.

PTE: The Internet is an ever-growing trove of technical data, educational opportunities and other gear industry-related information. How do industry associations such as AGMA market themselves in order to demonstrate their continued relevance and to grow membership?

Franklin: The Internet is certainly a valuable tool that leads all of us to the depth and variety of information, making it a real productivity-enhancing tool. We know from a variety of sources that our members and others in the industry really do save time with the Internet; it allows us to be much better prepared before we enter a meeting or visit a trade show than anything before it. However, AGMA is much more for our members than a source of information or a library.

AGMA is, of course, an excellent source of technical and business information that our members and others in the industry use to stay current with their design, manufacture and business issues. But these are not the main reasons companies join and continue to be members of the association.

Manufacturers in our industry become members of AGMA for three main reasons—access, credibility and voice. Access means connections, the networking opportunities that members of AGMA, almost uniquely, have in this industry. Access is the ability to meet with other like-minded technical and engineering staff in the development of new industry standards. Access is the ability for business managers to tour each other's plants and to discuss noncompetitive—but very valuable—information in a safe environment. Access is one of the primary ways that knowledge is transferred in our industry.

Companies that join AGMA enjoy an increasing credibility, from the first time they include the AGMA logo on their letterhead or in their product material on their website. Their customers know that our members regularly get the most current technical information and the most valid comparative

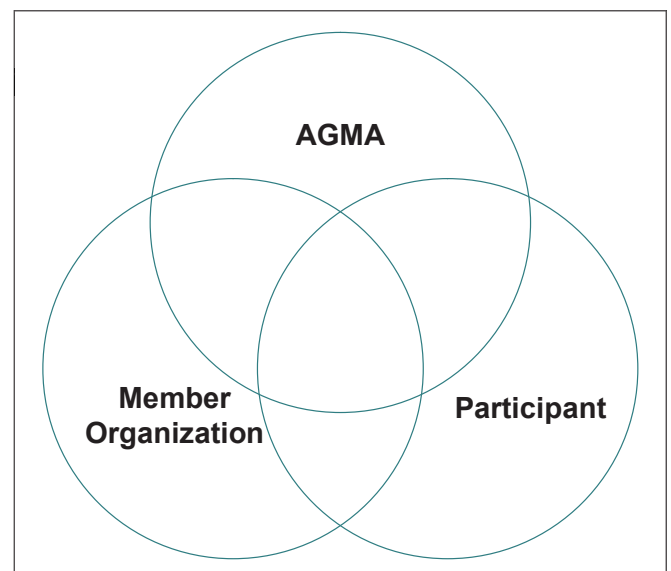
business information of anyone in the world.

The issue of credibility is not limited to smaller companies. Not long ago, at an industry meeting, some of the most respected and largest companies in our industry specifically commented that they benefited from enhanced credibility in the eyes of the customers because of their membership in (AGMA). These executives talked about experiences they had had working with customers and how they had used the fact that their engineers sat at the table where technical standards were developed.

And the final reason companies join and renew their membership is summed up in the word 'voice.' Anyone truly familiar with the association knows that AGMA's agenda is set by our members.

In example after example, it is easy to see new programs that we've started and new directions that we've taken, all because one or two members took the initiative to make a suggestion or request. The gear training school that we hold at (Chicago's) Daley College is one example of an excellent program started in the early 1990s because a small group of members recognized that the pool of trained workers was declining. Instead of complaining or pointing fingers at others who were not doing their jobs, members of AGMA decided to build a school to train workers so that we would all benefit. The school has been a tremendous success. Most of the other advanced engineering seminars that we teach came directly

continued



from other ideas submitted by members. The business reports that we produce are all the result of requests from our members.

Unfortunately, just as the Internet helps improve productivity, it also is a major source of data without meaning or context. Fortunately, through AGMA, our members use their access and voice to turn data to information and information to knowledge. As a result, their credibility grows.

PTE: With the oft-chronicled state of the gear, power transmission and motion control industries' graying ownership, management and workforce issues, how particularly important today is the work of AGMA's Future Leaders Council?

Franklin: What began two years ago as the Future Leaders Council has matured into a self-directed group of younger managers in the industry now named the Strategic Resources Network. After a few meetings, they recognized the strength of their group and the fact that not everyone in it wanted to be a "leader" in AGMA. They did want the benefits of participating in this council and ultimately viewed themselves as a network of resources, so they adopted the name Strategic Resources Network. This is a group that came out of a strategic planning session and was formally launched at the 2006 Annual Meeting. Since that time, they have been going through the typical growing pains of establishing their mission, identity, leadership and member base.

The participants in the network have a clear vision and understanding of who they are, what they want to accomplish and how that relates to AGMA. This is best represented by the chart that they created to show these interrelationships (See Fig. 1). Secondly, based on what they have created to define themselves, they have really demonstrated why they have grown to be key individuals within their organizations and why they will be the core contributors to not only their companies, but to the industry.

The thoughtfulness and skill with which they arrived at this is reflected in their name change to the Strategic Resource Network. This new name more clearly conveys the breadth of the members that they see playing key roles in the gear industry as we look to the future. Also, AGMA members should look within their own organizations for those individuals you view as being key contributors to the future of your company. They may benefit by participation in this new and exciting group. (Editor's Note: For more information on the Strategic Resource Network, please visit www.agma.org to view AGMA's Power Point presentation.)

PTE: What are the major issues facing AGMA through the rest of the decade?

Franklin: One of the strongest characteristics of AGMA's

board of directors is their tendency to look at the big picture—large issues that our industry faces—and then challenging the association to develop and implement solutions. Analyzing the industry from a variety of perspectives gives the board an excellent handle on current affairs and anticipated issues.

One of the major issues facing the industry is the recruitment and training of suitable workers for the industry. The other major issue facing manufacturers and members of AGMA today is how to remain competitive as our national commitment to manufacturing declines.

In the early 90s, several of our members recognized that the traditional pool of workers was getting thin. In far too many cases, trained and skilled employees were simply not available. The solution was for AGMA to create its own training school for gear manufacturing. Today we run (the aforementioned) gear school at Daley College, one of the city colleges of Chicago and an exemplary technical school focusing on manufacturing. That single step became the first of a number of programs that now constitute a substantial body of educational programs available to the industry.

Over the years, hundreds of operators and others in the industry have gone through the school in Chicago, where they've learned not only the theory of gearing, but—because of the hands-on laboratory—also had an opportunity to make their first gear.

While most of the students in the school are machine operators, with that a substantial number of sales engineers, advertising representatives and presidents of several companies have gone through the school. All who have taken this course are more valuable to the industry than when they first began.

AGMA also offers a variety of other ways to get the industry's employees trained and educated. We have expanded our education programs—again driven by requests from our members—into more advanced areas. (They include) gear and gearbox failure analysis courses; advanced gear design, and one in forensic analysis of gear and bearing failure. We have courses available on-line, or instructors will bring a course to your plant.

AGMA's business-oriented seminars, meetings and proprietary studies and surveys are intended to help all of our members to be more competitive. Our board has identified additional ways of helping members, and we will be introducing new programs in 2008.

Manufacturing is a key part of all industrialized economies and plays an important role in a developing country's future. I think we will see AGMA taking a bigger role in the promotion of manufacturing in all of our countries in the next year.

PTE: What assistance, insights or other benefits can AGMA provide for gear buyers?

Franklin: AGMA is anything but a provincial organi-

zation; we welcome every aspect of the gear manufacturing process into our membership. Of course, gear manufacturers make up the largest portion of our membership. But we also have suppliers of machine tools, other equipment, raw materials, manufacturing processes and service providers as members. Users (buyers) of gears are an especially important part of the membership.

Buyers/users of gears join AGMA for several reasons. First, since only members can participate on the committees that draft the technical standards, users understand the importance of participating in the full process. They are able to make their requirements and objectives known as well as bringing the practical side of manufacturing to the discussion.

In turn their ultimate customers have the confidence that their supplier—the gear buyer—is up to date on the latest technical developments and requirements. AGMA membership enhances their credibility.

Participation with their suppliers puts the buyers in the strongest possible position as they can constantly evaluate their current partners and see, first hand, who else is in that market. As they say, knowledge is power.


Finally, since AGMA's members include both gear manufacturers and the suppliers to the manufacturers, gear buyers have the ability through their networking and friendships in AGMA to look at their decision to buy gears and ask whether they should move from a buyer to a manufacturer. Participation allows them to do the make-buy calculation quietly and with full information.

PTE: Why should a gear buyer care whether his supplier is an AGMA member or not?

Franklin: Buyers should be concerned, and we know many are. It is not uncommon for a non-member company to call, asking, "How quickly can I get a membership certificate?"

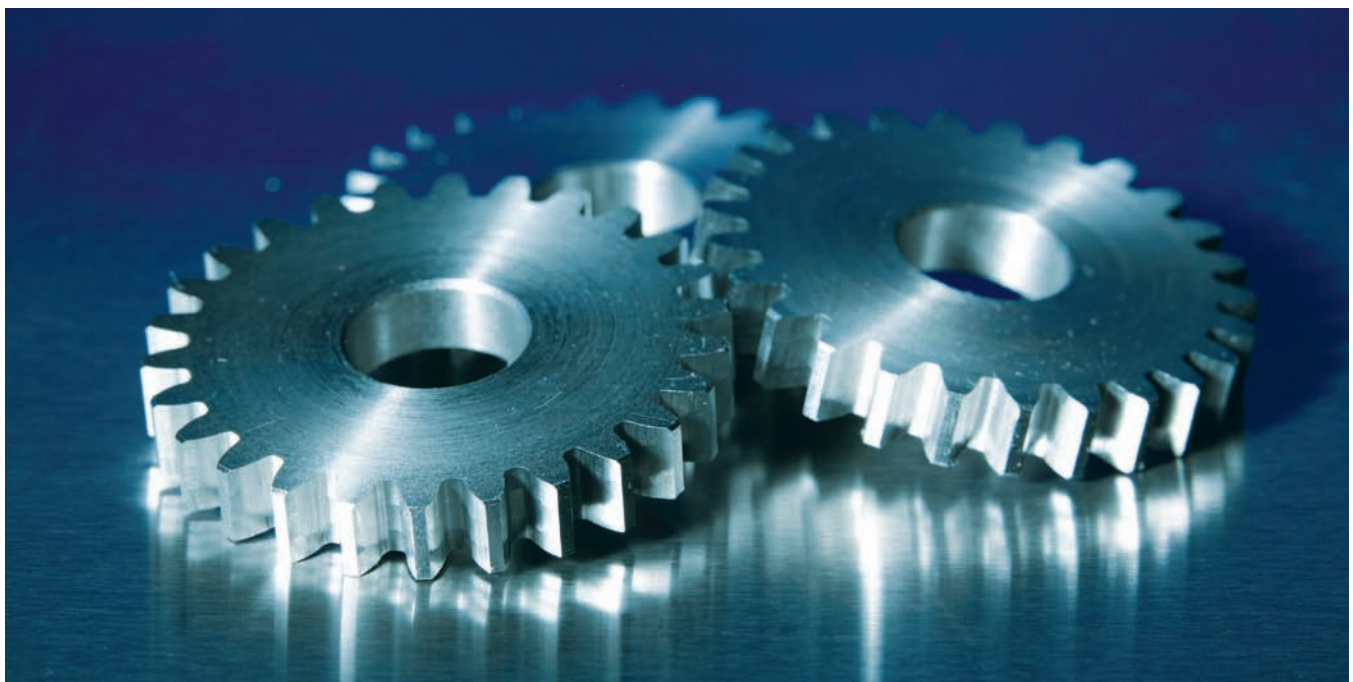
The reason is many large engineering projects require that the suppliers of gearing be members of AGMA. Why is that? Essentially it comes back to a word I used earlier—credibility. These buyers know that AGMA members have open access to the best technical thinking in the business. All members receive all AGMA technical standards and information sheets as they are published. Active members regularly participate on the committees where the industry's experts gather to develop the best current knowledge on a variety of manufacturing topics and processes.

Members have regular access, through their informal networks, to evaluations of machine tools and to the latest process knowledge and manufacturing techniques. There is simply no way someone out of touch with the industry can keep up.

Smart buyers know that when one of their suppliers has the AGMA logo on their materials and web site, the likelihood of a positive result is greatly increased. 

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How to Design A Better Servo Control System

Lee Stephens, Danaher Motion



Servo control system engineers design systems that involve complex motion, such as this flat-panel display processing machine that incorporates a high-precision gantry system from Danaher Motion.

Servo control system engineers typically work designing new systems or re-designing existing systems for conveyors, pick and place machines, gantries, machine tools or other equipment. Of course, the new design task starts with a clean sheet of paper. Since this system did not exist before, all the specifications must be derived from calculations, simulations, or actual measurements on existing machinery. Engineers can measure feeds, speeds, loads and torques on similar equipment that operates without servo controls, or they can simulate them with a variety of software packages. On the other hand, servo control system en-

gineers might have to redesign an existing system that typically comprises older analog controllers, sensors and drives.

Some might expect that designing a new system would be more difficult than replacing an old one, but often, this is not the case. Although the necessary loads, speeds and torques might be known, a newer digital controller behaves differently than the old analog system using brushed DC motors that it replaces. New control laws often enter the equation, and when the designer is not aware or does not anticipate these differences, the first system off the drawing board might not live up to expectations.

One major factor to consider in the new system is calculation time. A digital system works in three serial, quantifiable steps: measure, calculate and output. The controller requires specific time slices to run through these three functions. The calculation period might be so long as to let the system wander out of control. An analog system does not have this particular drawback to the same degree. By comparison, the analog system “calculates,” measures and outputs almost simultaneously and continuously. Typically, the lag time is not as severe.

Both new and replacement systems follow the same basic laws of physics

but different control laws, so the design approach and hardware shopping list could be very different for each system. For example, a new system design can be defined in two ways. The first is straightforward, where the controls engineer designs a system totally on his own from the ground up. He completely defines the system and orders the components needed to do the job. He alone is responsible for the outcome.

On the other hand, a new system might involve a client that has a resident engineer who helps define the system parameters and selects the components. The consulting motion controls expert may help design the client's new system after its resident engineer had already selected a few key components. The resident engineer may have determined loads, speeds and torques from actual measurements, calculations or simulations based on a few assumptions. He also may have purchased some major components such as motors and transmissions based on these determinations before hiring the consultant. The consultant's initial posture is to assume that the components that the resident engineer selected are perfectly suitable. Unfortunately, sometimes, this is not the case. The assumptions may have been made under static conditions when they should have been dynamic, particularly regarding the load. Then the consultant has no choice but to revise the model to include the proper parameters.

Strategy

Calculation lag time is especially troublesome when a control system contains multiple axes. In a three-axis pick-and-place system, for example, the x, y and z axes all must converge simultaneously on a particular point. If a lag appears in any one or more axes, the component part could be set in the wrong place. To avoid this, first determine the bandwidth of the system. Measure the load inertia, determine how fast it must move, and more importantly, how fast it needs to settle. Settling time really dictates the bandwidth. Bandwidth does not determine the speed, but how quickly and precisely the load stops or follows a contour.

The bandwidth is usually defined in terms of its -3 dB point and the 45° phase shift. Don't prefer one parameter over the other; exceeding the -3 dB point and the 45° phase shift indicates that the system is out of control. For example, if the system is at -3 dB but it has a 60° phase shift, it was significantly out of control long before it hit the -3 dB point.

In digital systems, other functions affect the phase angle, which sometimes surprises the customer. It concerns current-loop bandwidth. It is calculated digitally, and the calculation delays become apparent. The delay is worse than a phase shift, but it is essentially the same thing. Phase is time in the frequency domain. The digital system may not have optimized control algorithms to calculate current, velocity or position. Then the digital system may have more of a calculation delay than the system can tolerate. It did not achieve the intended bandwidth.

Modeling

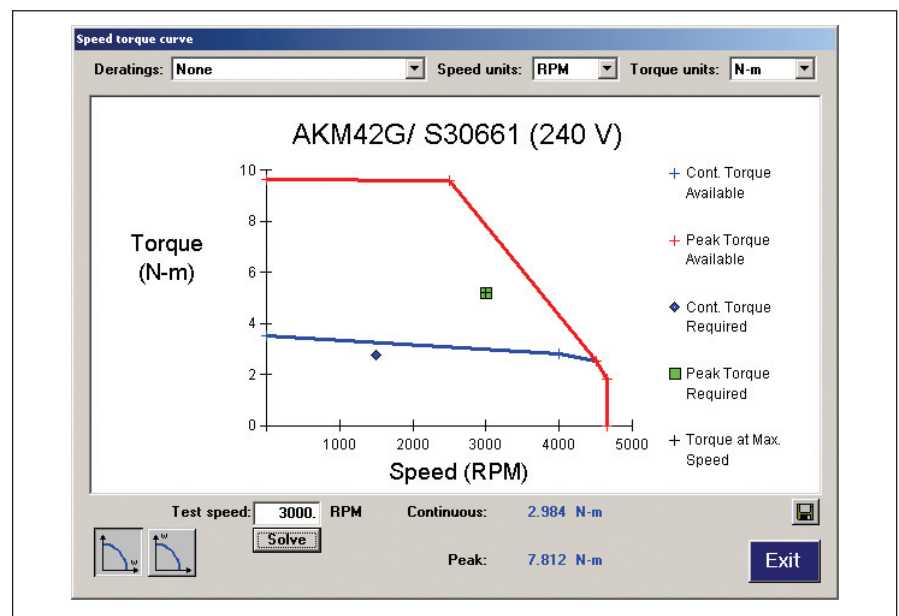
Some of the design work is carried out by modeling with a variety of software packages. Systems may be modeled in a digital format to determine not only the bandwidth, but also the position accuracy. The model can become as detailed as necessary.

Widely used software packages in-

clude *DisSim*, *Mathcad*, and *Motioneering*, which is available from Danaher. A *Motioneering* model for a typical PID controller lets designers examine the system behavior with numerous gains and other parameters. It can show a plot of this behavior with certain perturbations. *VisSim* also is a widely used simulation software package. A limited trial version may be downloaded free of charge from www.vissim.com. The trial version can run and modify a model, but it cannot save the model. However, the full purchased package performs the complete job. *Motioneering* is free and determines how much current and power the motor needs to function properly. *Mathcad* is another modeler that many designers use.

When modeling, it is sometimes hard to decide when to stop. When designers gain sufficient experience, however, they can recognize when some of the parameters are not relevant enough to consider. In the beginning, try everything on the list. Then narrow it down to the few parameters needed to adequately and sufficiently model the system. Any adjustments after that are usually minor. Stop when further detailing does not make the model any better or does not gain any more advantage in the design.

Often, designers return to the model continued



Engineers can use software such as *Motioneering* from Danaher Motion to model their systems before building them.

after the system did not meet specifications, and they find errors. They go through the system and might find that they should have considered something else that was more important. Always try to validate the model. It is only as good as the information that goes into it. Some information is difficult to determine mathematically and has to be done empirically. However, the empirical information determined for the model may not be sufficient, so use multiple formats, including the frequency domain and the time domain. *VisSim* and *Mathcad*, for example, work well together for this, so take advantage of them.

Validation

After the model is completed, the hardware may not yet be available to work with. The customer may have the breadboard and prove that the supplier's products will work in his system. However, the consultant may not be in control of how close the breadboard represents the real system. He may use the model as supplied, or he may revise it and find changes in pulley ratios, motors, inertias or miscalculated inertias. However, assume the physical breadboard is sufficient to model and validate the system. In the next step, the customer now implements the alpha or beta stage of the project and buys the needed components. When the system does not

meet expectations, sometimes the problem is a miscalculation; the system was expected to operate under certain circumstances, but maybe it could not. The model should have shown how much headroom there was and how close it was. If not, then it may be necessary to construct a Bode plot or run an FFT (fast Fourier transform) to find out why the system is vibrating, resonating, or not rejecting the disturbance. The ability of a control system to reject disturbances is a figure of merit that goes beyond a number; it is intuitive. It is through feedback that the disturbances will be rejected. The proper feedback loop will let the load reach the intended position. This might involve velocity, position or torque feedback. The nature of the feedback loop depends on the function that is specifically needed, such as torque or current for machining operations.

Feedback

The feedback system complexity varies with the application. It can be as simple as an incremental encoder or a resolver, and there are different reasons for using one or the other. A resolver is extremely robust and can tolerate harsh environments well. It can be a sine/cosine encoder, which can handle very high bandwidth, but typically, it does not survive well in a high-vibration, high temperature environment.

Some systems are more complex

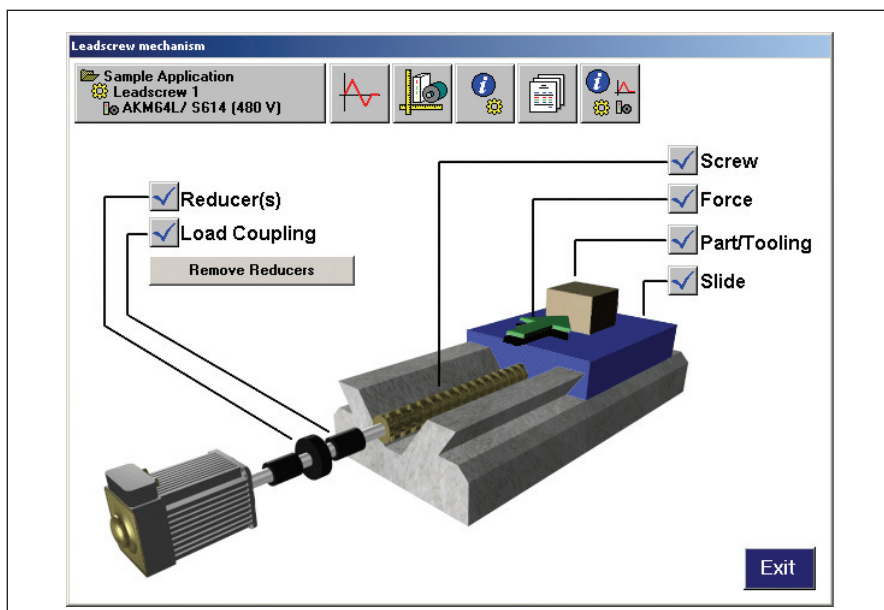
when they need a secondary feedback device. For instance, a system may require a feedback device mounted directly on the motor and another closer to the load. The feedback device on the motor could be used for velocity control, but the feedback device on the load would be used for final position. It doesn't sound too difficult, but as the feedback device moves farther from the transmission device (which is the motor here), more items will be enclosed in the loop. For instance, when a resonance appears at a certain frequency that is outside the intended control bandwidth, having the feedback device outside of the load is certainly going to help move the load to its final position. However, this system is extremely difficult to tune. Tuning this system means getting the position system up to the desired performance level. Therefore, when a very high-bandwidth position loop is needed, a secondary encoder is typically placed at the end of the position loop.

Redesign

During tuning, sometimes the controls engineer will find that rather large modifications must be made to the system to gain the intended control. He may even have to change his entire theory regarding the method needed to tune the system.

The simplest control methods, either PID (proportional, integral, derivative) or PIV (proportional, integral, velocity), usually operate in a great number of systems. For example, a standard PID control system is relatively easy to tune. It can be used for either a new system or an old one. Here, the velocity is a derivative of position and used for damping. The proportional term is a gain factor.

Also, a math calculator using a pole/zero function or a post filtering biquad filter method can help in the design. But either has certain advantages and disadvantages. The PID is probably the simplest to understand and implement using classical control laws. During testing or any time the system is in production, however, some control laws may need changing. After some use, however, the first single PID system may not appear to work sufficiently well. It may require




Motioneering helps determine how much current and power a motor needs to function properly.

two PID systems, a biquad system, or additional low-pass or high-pass filters.

Stiffness

System stiffness, or a lack of it, seems to be a major, chronic problem. For instance, resonance problems indicate that a system is not stiff enough. Moreover, backlash in a system is another serious problem. Here, the customer may have a linear motion control system that specifies a rack and pinion transmission on a precision axis. However, such a single-format gearing system produces troublesome backlash. Even anti-backlash gears cannot solve the problem; often they still have enough backlash to create instability. They typically contain two gears in parallel. One is spring-loaded against the other, and the teeth are clamped from two different directions. That arrangement does not guarantee zero backlash, only that the backlash is taken up by another mechanism. They have a spring rate to contend with, which is a dilemma when trying to control a frequency in the domain of the spring rate. It is a common problem, usually found in a system designed by someone lacking controls experience.

To overcome these problems, conduct Bode plots and LaPlace transforms in the frequency domain. Compare the Bode plot performance with the LaPlace transforms and tune the system based on that information. Observe the frequencies, disturbances and amplitudes, then determine the best method of attack to eliminate the disturbances, or insert compensation to reject it. In addition, stiffen the system to eliminate resonances, and raise the frequencies above the frequency of disturbance. Also, sometimes the system may be damped, but this could also affect the compliance. High frequency damping usually does not add compliance, but at low frequencies, damping certainly cannot be added because it adds compliance that exacerbates the disturbance itself. Try using acceleration feedback, a Lowenburger observer—a relatively complex algorithm—or select a suitable filter. 

For more information:

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1500 Mittel Blvd.
Wood Dale, IL 60191
Phone: (540) 633-3400
Fax: (540) 639-4162
Internet: www.danahermotion.com

Motion Engineering Software

The following resources provide software that may be valuable in developing motion control systems.

Mathcad **PTC**

140 Kendrick St.
Needham, MA 02494
Phone: (781) 370-5000
Fax: (781) 370-6000
Internet: www.ptc.com

Motioneering **Danaher Motion**

1500 Mittel Blvd.
Wood Dale, IL 60191
Phone: (540) 633-3400
Fax: (540) 639-4162
Internet: www.danahermotion.com

VisSim **Visual Solutions Inc.**

487 Groton Rd.
Westford, MA 01886
Phone: (978) 392-0100
Fax: (978) 692-3102
E-mail: info@vissol.com
Internet: www.vissim.com

Lee Stephens is a systems engineer with Danaher Motion in Wood Dale, IL.

The Search for Intelligent Brakes



Figure 1—View of two antenna elements of the Allen Telescope Array at Hat Creek.

The Allen Telescope Array at Hat Creek, CA is a joint venture between the University of California Berkeley and the SETI Institute of Mountain View, CA. SETI has hired Minex Engineering of Antioch, CA to help with the design and installation of state-of-the-art drives and controls for the antenna array. The array will ultimately consist of 350 offset parabolic antennas distributed over an area about 1 kilometer in diameter. The instrument will be used simultaneously for astronomy projects and the search for intelligent life.

The Allen Telescope Array will be an astronomical instrument unlike any other. First and foremost, it is the only major

radio telescope purposely built for the search for extraterrestrial intelligence. It is a telescope of unusual design, constructed from a very large number of relatively small antennas. Forming a large radio “mirror” in this way has long been recognized as a technically sound idea, but—until now—an impractical one for an array of such capability. The cost of electronically connecting hundreds of antennas together was prohibitively high. However, thanks to the rapid pace of the digital revolution, what was once impossible is now both feasible and attractive.

The Allen Telescope Array will cost only about one-fifth

as much as conventional radio telescopes of similar collecting area. And because it is an array, rather than a single dish, it can rapidly make detailed radio “photographs” of the cosmos. Each antenna is about 6 m in diameter and is positioned using a turntable bearing with pinion and large gear for azimuth moves and a ball screw drive for elevation moves.

This number of antennas yields approximately one hectare (10,000 m²) of geometric collecting area, about the same amount as the 100-meter telescope at Greenbank, WV.

The azimuth or vertical axis of the antenna has a gear ratio of 4,800:1 from motor to antenna and averages about 8,000:1 on the elevation or horizontal-axis drive. The output pinion on the azimuth drive unit uses a 160:1 harmonic drive to deliver more than 10,000 in.-lbs. of torque with a 2.5" pinion using a motor about 3.3 x 3.3 x 5.8" dimensions. Once this module is installed, the gear train operates with 57% efficiency and can be successfully back-driven. Both axes use the same motor, a Kollmorgen AKM-42 brushless servo motor and Copley Controls amplifiers. On both azimuth and elevation axes, the Ogura SNB Series brake is used to hold antenna position during power failures or other loss of control by the motors. The brake has been sized so that during severe wind conditions, the drive can be back-driven to allow the antenna to point downwind to its designed survival position.

With so many antennas planned, a low-cost design with efficient components is critical to the success of the project. Since wind load on an antenna is one of the main drive system design issues, the wind is allowed to overpower and back-drive the antenna when wind speeds exceed 50 mph. Wind speeds like this are not common but can occur a couple of times per year.

Most spring-set brakes are designed for holding loads at zero rpm or maybe a few emergency stops. Few are rugged enough to be suitable for repeated braking in dynamic situations or applications. In this application the brake’s normal function is to hold. But in the event of winds in excess of 50 mph, the antenna begins to move (this is a safety mechanism to prevent damage to the antenna). In the event of high winds, the locked brake acts as a primary dynamic brake, absorbing the energy and dissipating the frictional heat through its flat pancake design. Unique, proprietary, long-life friction materials in the SNB series brake allow aggressive holding power, but with enough low-coefficient materials to allow a steady, controlled slip without damaging the brake or wearing out too rapidly. Braking force is produced via springs, so basic fluctuations in voltage and temperature have no effect on the brake force.

Minex chose the Ogura SNB 0.2G because it provided easy integration into Minex’s design, and it came in a range of sizes and friction levels, says Matt Fleming, Minex engineer. Also, Fleming added, the brake allowed for motor replacement during a light wind and was cost effective compared to other options. Finally, the Ogura brake allowed Minex more independent choices of motor suppliers, Fleming said. “We considered motors with integral brake systems but found

them less attractive.”

Ogura specializes in spring-set, power-off brakes that can take the abuse of multiple dynamic braking events without damage or excessive wear. For this reason, the company’s brakes are common in the robotics, semiconductor and machine tool industries.

“Ogura was very pleased to have helped Minex provide a cost-effective, maintenance-free solution to this far-reaching antenna array,” says Fred Cacace, Ogura industrial product

continued



Figure 2—View of several additional antennas with the assembly tent in the background.



Figure 3—View of the azimuth drive unit removable module.

How The Ogura SNB Spring-Set Brake Works

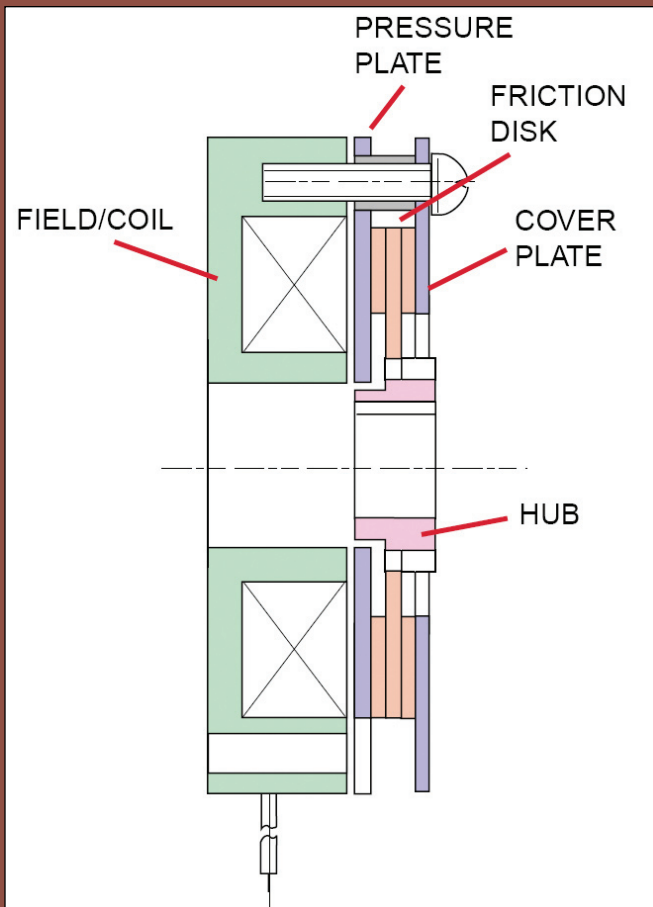


Figure 5—Above is a closer view of the Ogura low-profile SNB Series brake on the azimuth drive unit. In the event of full power loss, the brake can be unplugged and powered by a battery so that the unit can then be driven with an electric drill motor and 3/4 hex socket.

Engagement: When no current/voltage is applied to the brake, a series of springs push against the pressure plate, squeezing the friction disk between the inner pressure plate and the outer cover plate. This frictional clamping force is transferred to the hub, which is mounted to a shaft (customer supplied). The power-off brake is considered engaged when no power is applied to it. It is typically required to hold or stop a load in the event of a loss of power, when power is not available to run a machine.

Disengagement: When the brake is required to release, voltage/current is applied to the coil, creating a magnetic field. This magnetic field pulls in the pressure plate, pulling against the springs, creating an air gap between the pressure plate and the friction disk, and allowing it to turn freely with the shaft.

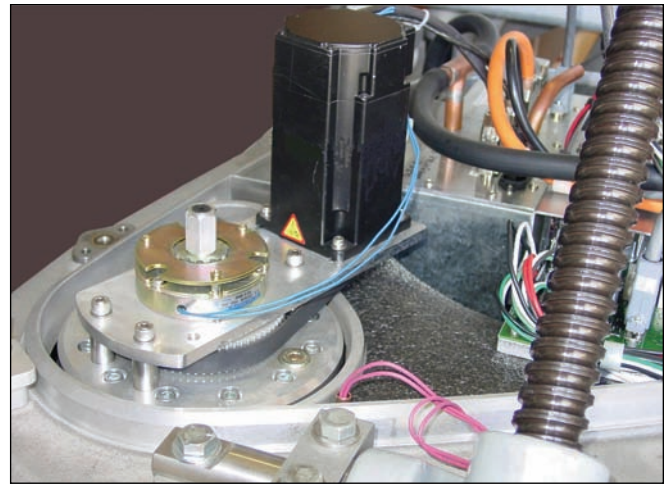



Figure 4—View of the azimuth drive module installed on an antenna.

manager. “Ogura was on time and within budget with 100% quality.” 

For more information:

Minex Engineering
1000 Apollo Ct.
Antioch, CA 94509
Phone: (925) 757-6785
E-mail: mcfmec@pacbell.net

Ogura Industrial Corp.
100 Randolph Rd.
Somerset, NJ 08873
Phone: 732-271-7362
Fax: 732-271-7580
E-mail: fcacace@ogura-clutch.com
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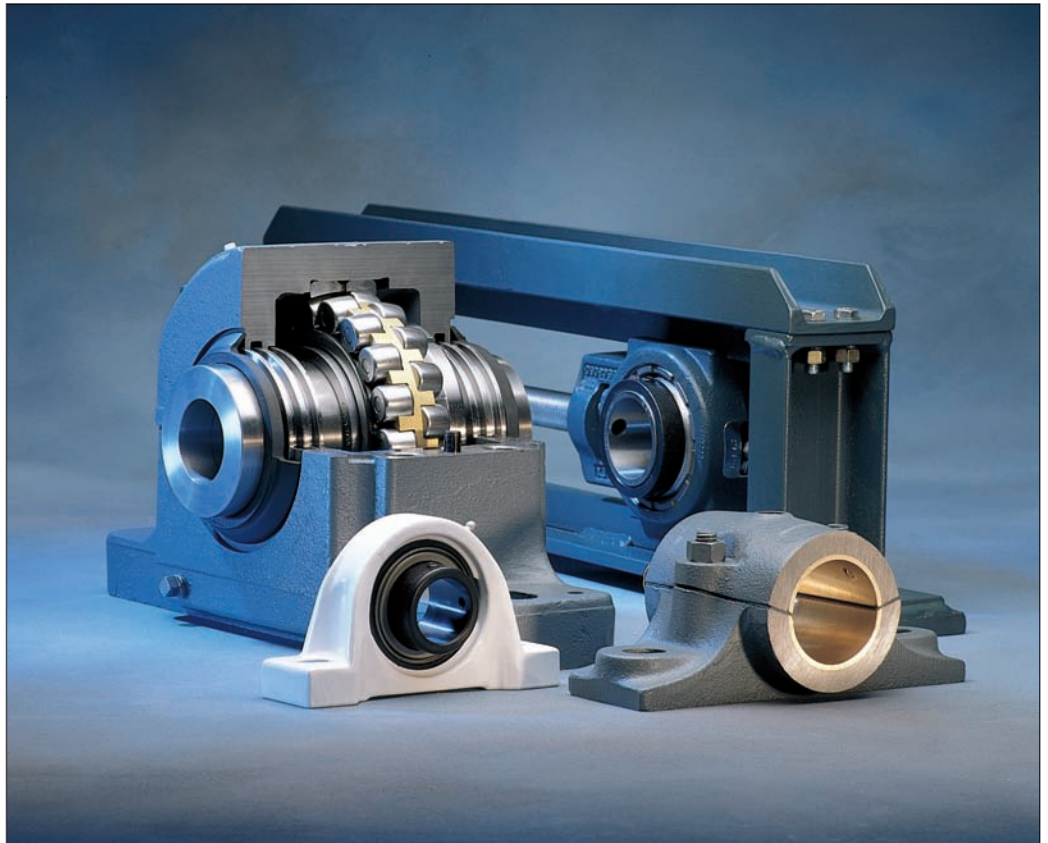
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Bearings for High Temperatures

Doug Payne, Rexnord Bearings



Introduction

When rolling element or sleeve bearings operate under extreme conditions, it's more important than ever to follow proper lubrication selection and maintenance procedures to maximize effective life and efficient performance. Long-term analysis of field data shows that the lack of proper lubrication is the most commonly cited cause of bearing failure and accounts for over 40 percent of breakdowns (Fig. 1).

Lubrication is vital to achieving proper life for bearings. In applications such as furnaces, ovens, or high-temperature fans and blowers, bearings may be exposed to higher-than-normal temperatures. Other areas include steel mills

and foundry equipment such as continuous casters and roll-out tables, as well as dryers, electric motors and generator sets. In these applications, proper lubrication selection is even more important. There are two types of lubricants that are suitable for high-temperature use. One is traditional grease lubrication, and the other is an oil system. Oil systems can be static or circulating. Operating temperatures are one of the major considerations when selecting the method of bearing lubrication and determining the grade of oil or grease.

Greases or oils used in applications that exceed the lubricant's designed temperature limits deteriorate rapidly and carbonize or harden within the bear-

ing and housing cavity. Deterioration is caused by the initial evaporation of the higher volatile components of the oil, or the oil additive mixed in the grease, and continues until the grease eventually loses lubricity and is rendered useless as a lubricant. Evaporative loss of the oil in the grease, coupled with the oxidation of the oil and soap base structure, will ultimately cause the grease to transform into a semi-hardened or hardened solid. Conventional greases and oils will usually withstand operating temperatures up to 200°F (93°C) before effective life is deteriorated.

When operating temperatures exceed 200°F (93°C), special consideration must be given to the type and method of lubrication. Petroleum-type greases and oils are available that will operate satisfactorily for temperatures up to 250°F (121°C) continuous, or 275°F (135°C) on an intermittent basis. The petroleum-grade oils used at this temperature range should be of a quality high-temperature or highly refined turbine-type lubricant. These oils are more stable and have a lower evaporation rate than most conventional, universal-type oils.

At continuous temperatures of 250 to 320°F (120–160°C), synthetic greases have proven successful. The synthetic structure imparts a more stable characteristic to the grease, and the residue content is considerably less than that of petroleum lubricants at the elevated temperatures. Types of synthetic grease have been used satisfactorily for low to moderate operating speed applications at temperatures up to 430°F (220°C).

At temperatures above 250°F continuous, the use of static oil should be confined to low-speed applications. This system has a pool or sump in which the bearing operates partially submerged. It is recommended that the speed be held to a DN value (bore in millimeters times rpm) not to exceed a 50,000 to 75,000 range on the higher-temperature applications because of oil's greater deterioration rate compared with greases. This higher deterioration is a result of the added churning and aeration effect, which tends to oxidize the oil.

continued

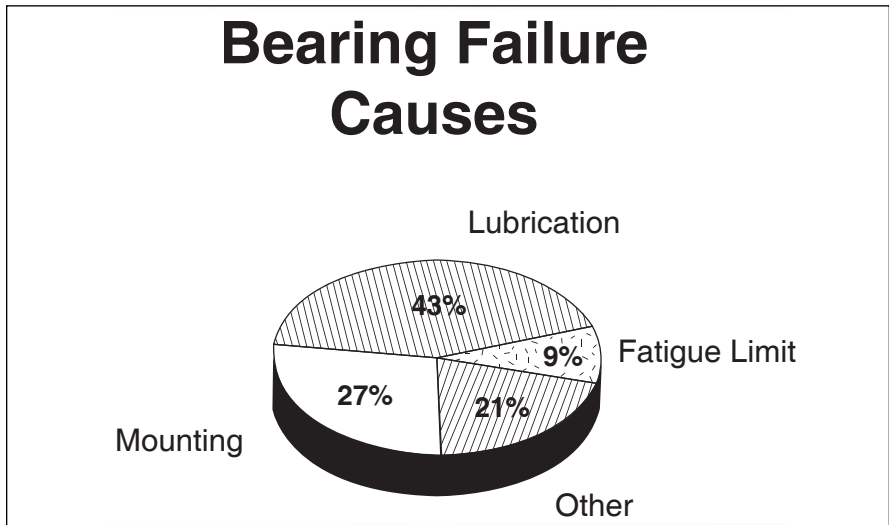
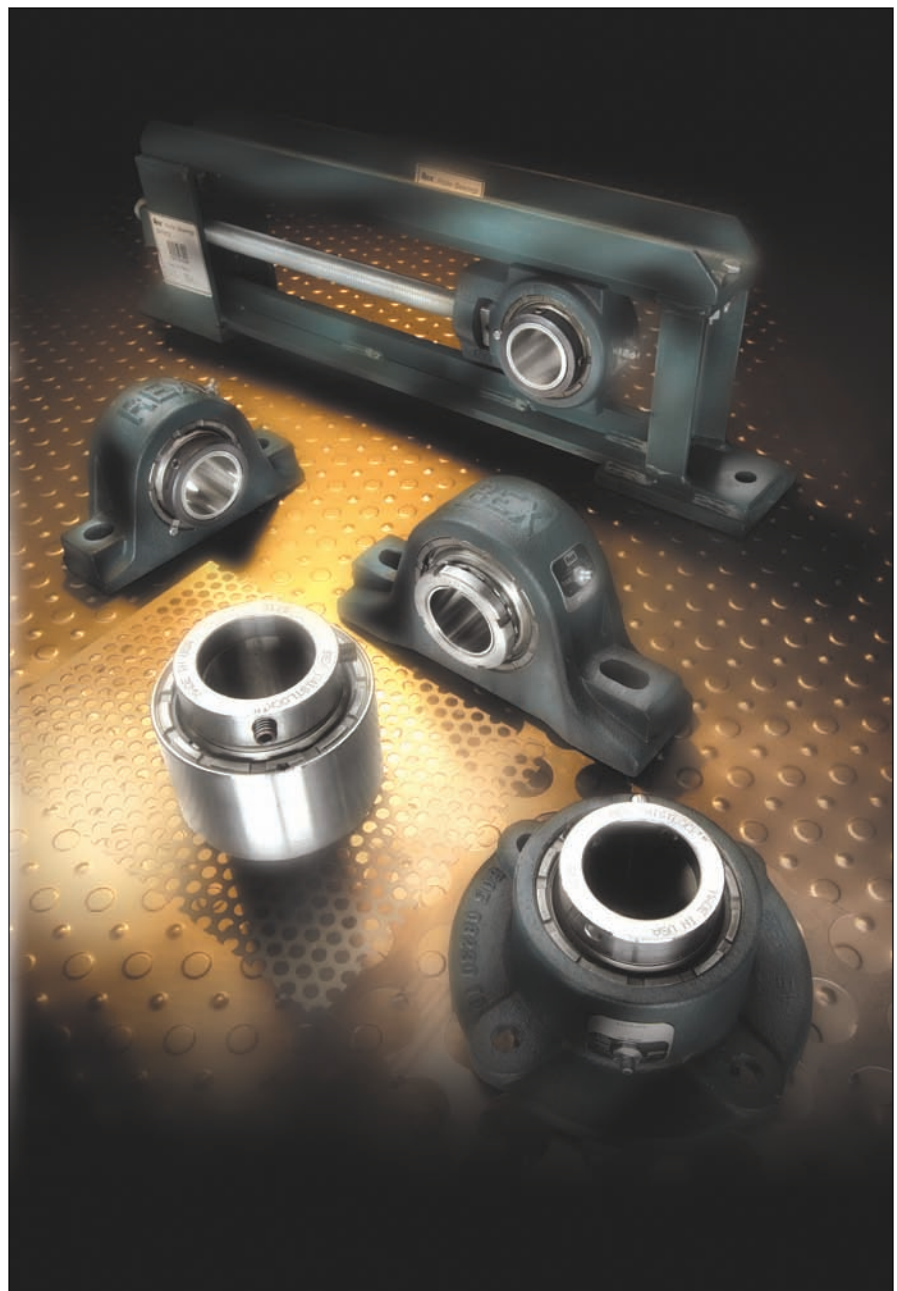


Figure 1—Bearing failure causes.




Ultimately, a properly designed circulating oil system (Fig. 2) is the best approach for continuous operating temperatures above 250°F (121°C) or where a high degree of operating reliability is desired for temperatures over 200°F (93°C). Synthetic oils can be used in these systems and are recommended in applications where temperatures are above 250°F. A method of cooling the oil, which will allow for maximum heat transfer, should be included in the design. This will also prolong oil life and provide the maximum return on investment. Consultation with an oil system supplier is recommended to provide technical guidance on equipment design. A circulating oil system can have a higher initial and operational cost due to the additional equipment required. This can make cost justification difficult if premature failures have not been experienced. However, a circulating oil system remains the best solution for bearing lubrication in a high-temperature application.

Synthetic greases and fluids can handle higher temperatures, but they may require some restrictions to bearing speed and applied load design parameters, depending on the actual synthetic product used. As a general guide for high-temperature usage, it is advisable that loads be restricted to approximately 10 percent of the bearing dynamic capacity and 50 percent or less of normal speed limit as catalogued by the bearing

manufacturer. Operation of bearings beyond these limits can lead to rapid wear of the bearing components and raceway surfaces, caused by micro-spalling and/or metal-to-metal contact. If greater dynamic capacity or speeds are required, performance characteristics usually can be extended by altering the bearing size within a particular series of bearings or changing to a different bearing style.

In addition to proper lubrication, it is possible to improve bearing life in high-temperature applications by making every feasible effort to locate the bearings out of the immediate heat zone or taking steps to reduce the operational heat level. Often, this can be accomplished by insulating the walls of furnaces or high-temperature fan casings to reduce radiant heat. The use of heat flingers or cooling wheels and disks along with high nickel-chrome, heat-resisting shaft material will also reduce the heat conducted to the bearings. For extreme high-temperature applications, specially designed, water-cooled housings will help reduce bearing operating temperatures.

As you can see, there are many factors to consider in determining proper bearing lubrication. By following these guidelines, you can have bearings that operate successfully, even in a high-temperature environment. 

For more information:

Rexnord Industries LLC
 Phone: (866) REXNORD
 Internet: www.rexnord.com

Doug Payne is manager of application engineering with Rexnord Bearings in Indianapolis.

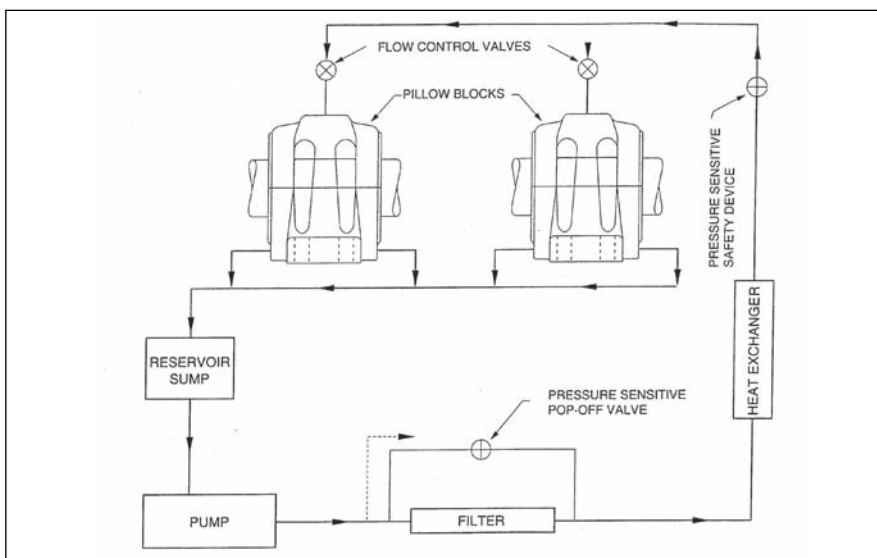


Figure 2—Design for a circulating oil system.

calendar

October 10-13—PTC Asia 2007. Shanghai New International Expo Center, Shanghai, China. Exhibition for power transmission and control, fluid power (hydraulics and pneumatics), mechanical and electrical transmission, compressed air technology, internal combustion engines and gas turbines. Organizers expect more than 1,300 exhibitors and approximately 58,000 visitors. For more information, visit www.ptc-asia.com.

October 18-20—Power Transmission Distributors Association Annual Summit. Marriott Desert Springs Resort and Spa, Desert Springs, CA. Main networking and educational event for the power transmission industry. Workshops scheduled include topics such as driving growth and shareholder value and understanding the demographics of the evolving workforce. Registration is available to PTDA members online at www.ptda.org.

October 22-24—International Joint Tribological Conference. Marriott Mission Valley, San Diego, CA. Focuses on research in the multidisciplinary field of tribology. Sponsored by The Society of Tribologists and Lubrication Engineers (STLE) and the Tribology Division of ASME International. Papers will be presented in all fundamental and applied fields of tribology, and will be in the form of two- to three-page (maximum) extended abstracts. Topical areas include: Tribomaterials and Tribology Fundamentals; Lubricants and Additives; Elastohydrodynamic Lubrication; Hydrodynamic Lubrication and Fluid Film Bearings; Rolling Element Bearings; Engine Tribology; Machine Components Tribology; Contact Mechanics; Magnetic Storage Tribology; Manufacturing/Metalworking Tribology; Nanotribology; Engineered Surfaces; Biotribology; and Emerging Technologies. For more information, contact the Society of Tribologists and Lubrication Engineers at www.stle.org or visit the official conference website at <http://www.asmeconferences.org/ijtc07/>.

October 31–November 3—Wind Power Shanghai. Sheraton Grand Tai Ping Yang Hotel, Shanghai, China. Turbine manufacturers and component suppliers can attend lectures by senior international executives on growth potential in the wind energy market from Oct. 31–Nov. 1. A trade exhibition will follow at the Shanghai International Exposition Center from Nov. 1–Nov. 3 and will include wind turbines, rotor blades, gearboxes, electricity generators and controlling and breaking systems. For more information, visit the show's website at www.windpowershanghai.com.

November 7-9—Gearbox CSI: Forensic Analysis of Gear & Bearing Failures—Useful Tools for Optimizing Gearbox Design. Sheraton Sand Key Resort, Clearwater Beach, FL. Instructors Joseph Lenski and Ray Drago promise to educate designers on the limitations and capabilities of the rolling element bearings and supporting gears so that designers can select the best gear-bearing

combination for any gearbox. \$1,895 for AGMA members \$2,395 for non-members. For more information contact the American Gear Manufacturers Association at www.agma.org.

November 13—SERCOS Seminar. Hilton Garden Inn Hotel, Chicago. The SERCOS trade associations are hosting a free one-day seminar on the latest advances for SERCOS in motion, safety and I/O. Attendees will learn about advances in the fiber-optic based SERCOS II, the features and functions of the new Ethernet-based SERCOS III, CIP Safety for SERCOS, the new SERCOS I/O profile, new controller-to-controller profile, components for SERCOS III designs, and complete SERCOS III automation solutions. In addition to the informational seminar, there will be a display of the latest SERCOS II and SERCOS III products from leading manufacturers. A free buffet lunch will be provided. For more information, visit www.sercos.com/news/events.htm or call SERCOS North America at (800) 573-7267.

November 21-22—Gear Finishing Technology Seminar. The Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University, Aachen, Germany. The seminar is for managers and experts for development, engineering, designing, researching, supplying, planning and manufacturing who deal with gear finishing. This conference will be offered with simultaneous translation into English. The topics covered are Green Finishing and Heat Treatment of Gears; Hard Finishing in Serial Production: Gear Grinding; Hard Finishing in Serial Production: Gear Honing; Hard Finishing of Large Module Gears; and Gear Quality Evaluation. The conference fee is €795; 20% rebate is available for participants from WZL Gear Research Circle member companies. Contact Aachen University of Technology via e-mail at K.Fausten@wzl.rwth-aachen.de or by telephone at + (49) 241-8020711.

December 4-7—2007 International Machine Components Equipment Manufacturing Expo. Chinese Export Commodities Fair Pazhou Complex, Guangzhou, China. Includes Bearing China 2007, Gear China 2007 and Fastener China 2007. Exhibits for Bearing China 2007 consist of standard and non-standard bearings like ball bearings, roller bearings, linear motion bearings, special bearings, bearings for specific applications, as well as production and related equipment, accessories, quality certification, testing and research services. Exhibits for Gear China 2007 include standard and special gears, gear production and testing equipment, cutting tools, machine accessories and manufacturing services, as well as a series of seminars on technical topics and market developments. For more information, visit the exhibition's website at www.bearingchina.com or contact Business & Industrial Trade Fairs Ltd. via telephone at +(852) 2865-2633 or via fax at +(852) 2866-1770.

Timken

TO ACQUIRE PURDY CORP.

The Timken Co. announced an agreement to acquire the assets of The Purdy Corp., a leading precision manufacturer and systems integrator for military and commercial aviation customers, for \$200 million.

Purdy specializes in the design, manufacturing, testing, overhaul and repair of transmissions, gears, rotor-head systems and other high-complexity components for helicopters and fixed-wing aircraft. Based in Manchester, CT, Purdy employs more than 200 people and had 2006 sales of approximately \$87 million.

“Purdy’s technology, manufacturing expertise and strong customer base make it an excellent fit with Timken’s growing aerospace business,” said Ron J. Menning, Timken’s president-aerospace and defense. “As we accelerate our growth in this strategic market, we plan to add capacity and capabilities to expand the range of power transmission products and services we can offer to create value for Timken’s global customers.”

The sale is subject to the customary antitrust regulation and approval process, but Timken expects to close the transaction in the fourth quarter of 2007.

Bishop-Wisecarver

FOUNDER FEATURED ON NAM RADIO

Bud Wisecarver, founder of Bishop-Wisecarver Corp., recently discussed his role as an innovator with Mike Hambrick, host of “America’s Business,” the National Association of Manufacturers (NAM) weekly, one-hour radio show. The show featuring Wisecarver aired Sept. 14 and 15. Podcast versions of the show can be found online at www.AmericasBusiness.org.

For a segment on innovation and creativity in manufacturing, Wisecarver described his company’s high-speed linear motion systems and how they are used to move machinery back and forth. He talked about the company’s founding in 1950 and how he designed and hand-built production equipment for the original plant in Pittsburgh, CA.

Wisecarver attributed his company’s staying power as a small business to his ability to innovate machinery that creates products.

“Everything—it doesn’t matter what it is—starts with a toolmaker,” Wisecarver said. “Without the toolmakers, you don’t have anything.”

TB Wood’s

CELEBRATES 150TH ANNIVERSARY

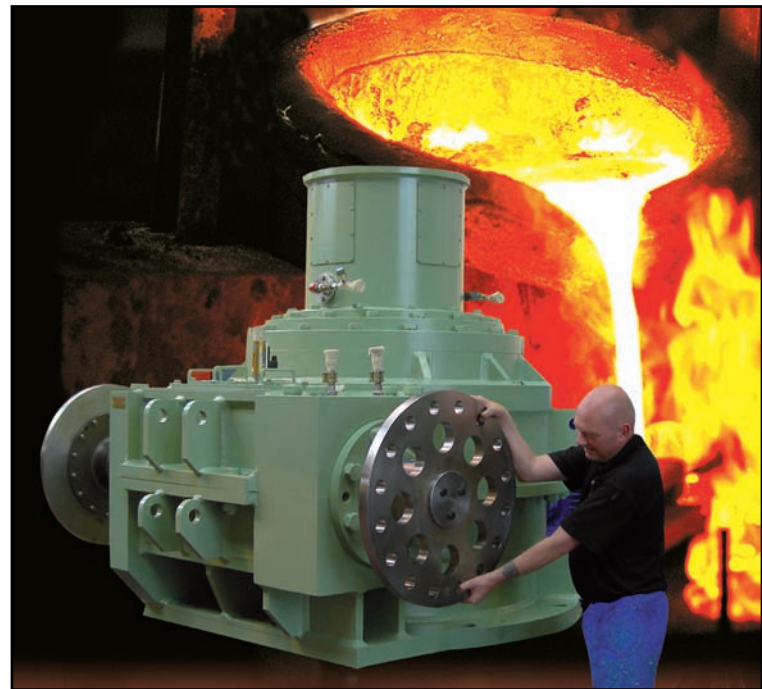
TB Wood’s Inc. is celebrating its 150th anniversary on October 27 with a day-long open house and party at its Chambersburg, PA headquarters.

Founded in 1857, TB Wood’s is a designer and manufacturer of electronic and mechanical power transmission equipment for industrial control. The company was launched when master mechanic T.B. Wood and his partner, Peter Housum, a millwright designer and machinery builder, bought Franklin Foundry & Machine Shop in Chambersburg. Initially, they produced wood-burning stoves as well as a wide range of mill gearing.

Today, TB Wood’s is owned by Altra Industrial Motion.

Renold

MANUFACTURES ITS HEAVIEST-EVER WORMWHEEL GEARBOXES



Renold Gears manufactured a pair of wormwheel gearboxes which combined weigh nearly 25 tons. The gearboxes, made for a steel mill in Asia, are the heaviest ever manufactured by the company, according to a press release.

industry news

Designed to retrofit an existing steel mill, the gear units will be the main drives of a screw-down mechanism used to re-form newly cast steel billets into thinner width sections. Driven by 220 kW motors, the gear units squeeze the steel into the required section widths.

The single-reduction worm gears are designed specifically for this application with a reduction ratio of 21.5:1. They are designed with a larger than normal tooth thickness to withstand static torque in excess of 530,000 Nm.

“Where sudden and huge shock loads are going to be encountered, only wormwheel sets manufactured with the maximum tooth width are suitable,” says Stephen Whitehead, sales director for precision gears. “Only the combination of hardened steel wormshafts and ‘soft’ phosphor bronze wormwheels allows these loads to be withstood with no detrimental effect on service life.”

One worm has a right-hand thread, and the other has a left-hand thread, so that the two units produce output in opposite directions when the inputs are in the same direction.

PCB Piezotronics

TO PRESENT INDY CAR DISPLAYS AT AUTOMATION TECH EXPO

PCB Piezotronics announced plans to partner with Andretti Green Racing (AGR) to present a special exhibit at the Automotive Testing Expo North America, October 24–26 at The Rock Financial Showplace in Novi, MI.

Automotive Testing Expo is the only North American show which combines dedicated automotive testing, vehicle dynamics and crash test exhibitions into one comprehensive event.

PCB will display replicas of Andretti Green Racing IndyCars in a special pavilion area, located at Booth #17024, as well as several larger-scale demonstrations of automotive testing applications.

“During a time in which our valued customers—including the Big 3 and Tier 1, 2, & 3 suppliers—are streamlining operations and investing in R&D toward the goal of more efficient, high performance, cost-competitive automobiles, PCB is committed to adding technical sales and applications engineering resources to support this effort,” says PCB president John Lally. “We look forward to demonstrating our technical capabilities in Novi, while also showcasing PCB products and our proud sponsorship of Andretti Green.”

As Official Sponsor of AGR, PCB supplies sensors and instrumentation, including DC response accelerometers, torque sensors and load cells, for its four IndyCar Series entries.



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Animatics Corp.

ANNOUNCES EXPANSION

Animatics Corp. has moved into a new, 104,000 square-foot facility in Santa Clara, CA.

According to the company's press release, this is the fifth expansion in the last two years. During that time, the company opened an office in Rochester, NY, acquired two companies and opened subsidiaries and regional offices in England, Germany and Japan. The most recent expansion is due to record sales growth, the release says.

The company started as a small CNC and general automation machine builder. Today it specializes in single-component motion control systems known as integrated motors. Animatics produces a patented servo version under the trademark "SmartMotors."

The new address is:
Animatics Corp.
3200 Patrick Henry Drive
Santa Clara, CA 95054
Phone: (408) 748-8721
Internet: www.animatics.com



Micronor's Fiber Optic Rotary Encoder System

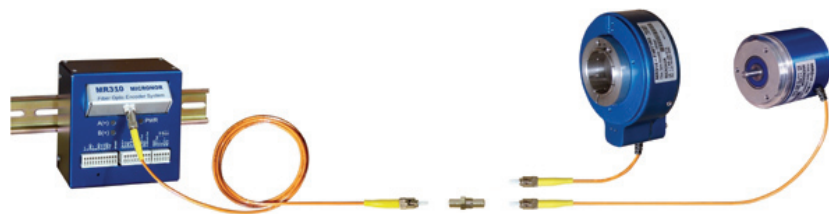
AWARDED U.S. PATENT

Micronor Inc. has secured U.S. patent 7,196,320 for its ZapFREE fiber optic rotary encoder system.

The patent recognizes Micronor's wavelength division multiplexing approach, which produces a totally passive encoder utilizing no electronics within the sensor. The encoder is therefore deployable in stressful environments not suited for conventional electronic-based encoders.

The Micronor encoders meet ATEX requirements as "simple apparatus" and are certified for use in hazardous environments. An MRI-transparent encoder has been recently developed for the medical industry.

The technology was commercially introduced in 2004 as



the MR3XX series ZapFREE Fiber Optic Encoder series. Customer applications now range from aerial cable cars to electric trains; from mines to steel mills to oil rigs. The sensors are offered in 100–1024 ppr resolutions as well as industry-standard shaft or hollow-shaft configurations.

According to the company's press release, the MR3XX sensors mechanically mount like any conventional rotary encoder, then connect by a simplex fiber optic link to a MR310 Remote Encoder Interface (REI) module. The REI module offers an array of standard interfaces (quadrature, serial 4–20 mA and , ±10 V, etc.) that ensures connectivity with all major motor drive, motion control and PLC systems.

Danaher Motion

INTRODUCES WEB-BASED SIZING AND SELECTION TOOL

Danaher Motion introduces *Linear Motioneering*, a powerful, web-based linear motion system sizing and selection tool that enables OEM and factory automation users to optimize machine design and operation in five steps.

Linear Motioneering guides users through a process for a slide table application to deliver all the data necessary to make a quick, logical system selection.

Deliverables include immediate 3-D CAD models in multiple formats, motor requirements, life and safety factor calculations, lead time and pricing information with options listed by price point, an automated e-mail of the inquiry and quote documenting the application, and a single part number to order from that includes all specified options.

Users simply enter application parameters, including mounting configuration, environmental conditions, positioning, loading and move requirements. With that information, *Linear Motioneering* recommends a choice of specific linear motion systems for the application.

The product solution recommended by *Linear Motioneering*, including any accessories and motor mounts, is assigned a "Smart Part Number" that the machine builder can use to order the linear motion system with all accessories pre-mounted and ready for integration into the machine. *Linear Motioneering* provides a detailed specification of the system and a summary of the loading and motion profiles, as well as an instant download of a complete 3-D CAD model provided in all of the most common CAD formats.

Users can select and specify the optimum linear motion system, and then load it into their machine design in a matter of minutes. In addition, users can view the list price and lead-time information, and request a quote online.

Overton Gear

CREATES NEW BRAND IDENTITY

Overton Gear of Addison, IL has recently unveiled a new logo and website to better highlight its facilities, processes and global capabilities, according to a press release.

"The need for a new identity was one of the action items that came as a result of our shift to 100 percent employee ownership," says Louis Ertel, president and CEO. "We wanted a new identity that would symbolize our renewed focus on infrastructure investment and our achievement of a thoroughly modern manufacturing facility."

The company has been adding new capabilities to meet customers' gearing needs, including new gear cutting, tooth grinding, inspection equipment and a 10,000 square-foot expansion of its heat treating facility.

To see the new logo and read more about the company, visit www.overtongear.com.

Heidenhain

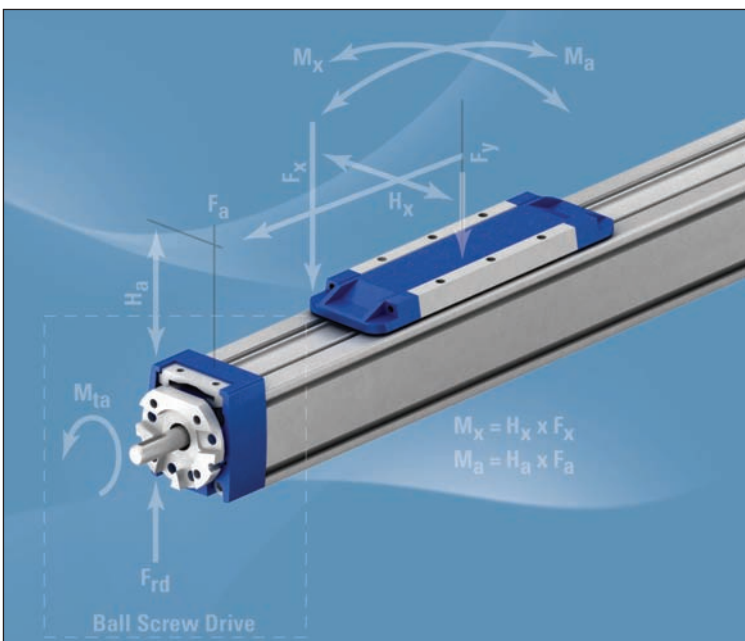
SHIPS 200,000 CONTROLS

In June, Heidenhain shipped its 200,000th NC control.

According to Heidenhain's press release, with over 30,000 units, the current iTNC 530 has succeeded the TNC 426 as Heidenhain's most successful model. More than 10,000 units of this model are expected to ship from Traunreut, Germany in 2007.

These NC controls feature user-friendly dialog guidance in applications that require shop-floor programming. Heidenhain controls guide the user with questions and prompts and automatically generate the program. Since 2004, the "smart.NC" operating mode has offered straightforward, fillable forms, interactive graphics and user aids.

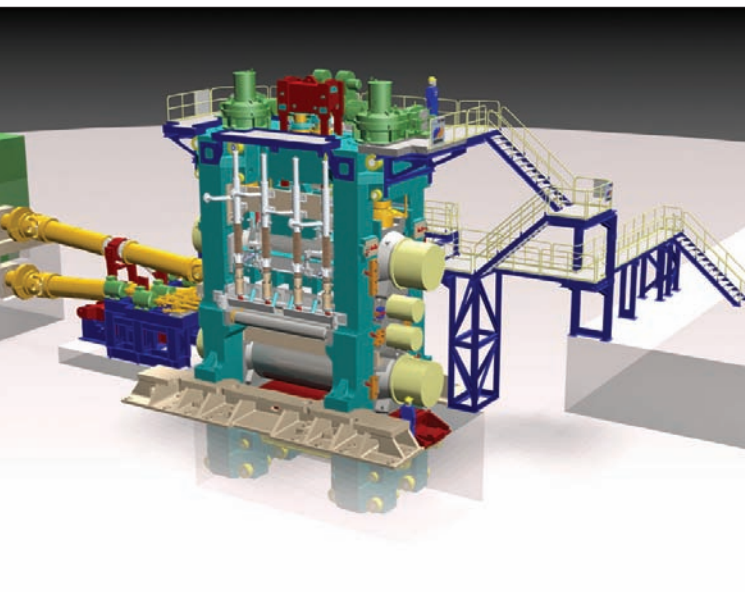
Heidenhain controls are widely used on machining centers and complex milling machines for five-axis machining. The iTNC 530 is designed for short machining times, high contour accuracy, short block processing times and optimal path control. In the mid-range, the TNC 320 provides precision in



manufacturing on machines with up to four controlled axes. The TNC 124, a straight-cut control for simple machine tools, is designed for less demanding control tasks. Controls for lathes such as the MANUALplus 4110 complete the product range.

Voith Turbo

SUPPLIES UNIVERSAL JOINT SHAFTS
FOR HEAVY PLATE MILL IN INDIA



Reports indicate that the growing demand for high-quality steel in India is leading to investments in improved production facilities. One example of this was illustrated by Voith Turbo's announcement that it has been contracted to supply Indian steel producer Jindal Steel and Power Ltd. in Angul with two universal joint shafts from the combined H/CW series, as well as a torque measurement system.

According to Voith Turbo's press release, the universal joint shafts are among the strongest and largest that Voith Turbo currently produces and are being used in a new heavy plate mill at Siemens VAI in England.

Guido Christ, sales manager for universal joint shafts at Voith Turbo, says, "The Indian steel market has been slumbering for almost 40 years. All this has now changed. For three years, per capita steel consumption has been increasing constantly, and this is influencing the demand for universal joint shafts for steel production."

After growth of 7.5%, steel capacity was around 44 million tons last year. Economic researchers expect production of raw steel to continue its growth at a rate of 6% annually. The Indian Steel Ministry estimates its export rate will increase

from 15–24% in the next 15 years.

The two H Series universal shafts that Voith is supplying to Jindal Steel & Power each weigh 60 tons and are designed for heavy load requirements. They drive the working rolls with a diameter of 1,100 mm in the new heavy plate mill at Siemens VAI. This rolls the steel slabs into plates up to 200 mm thick. The heavy plate mill in Angul is designed for a maximum slab width of 5 meters, currently the standard width. According to Voith, approximately 1.5 million tons of steel pass through a heavy plate mill every year, and the slabs are becoming increasingly large.

Working rolls that can be moved axially ensure the uniformity of plates. The new universal joint shafts, slated for delivery to India next year, feature improved bearing embedding. Flange dimensions optimally adapted for the flow of forces and reinforced journal crosses increase the torque capacity. To transmit extreme torques, the bearing bore on all Voith joint shafts has a jointless design.

A torque measurement system from Voith's subsidiary ACIDA will also be installed in India to monitor the functioning of the universal joint shafts.

Modest Rebound in Motor Demand

CONTINUES IN SECOND QUARTER OF 2007

Shipments of integral and fractional horsepower motors increased for the second consecutive quarter, as NEMA's Motors Shipments Index increased 2.8% on a quarter-to-quarter basis during the second quarter of 2007.

On a year-over-year basis, the index suggests that underlying gains in motors demand growth remain small, with a 0.1% gain in the topline index compared to the second quarter of 2006.

Nonetheless, the motors shipment index has increased 56% from its low point in the last economic downturn.

According to NEMA's press release, given the optimistic prospects for capital spending, as well as strong export demand, integral horsepower motors will likely continue to see modest gains in demand going forward. By contrast, end-market conditions have soured for fractional horsepower motors and are expected to remain a limiting factor to future gains in the topline index.

The NEMA Motors Index is a composite measure of NEMA-member companies' U.S. shipments of fractional and integral horsepower motors. Product shipments data are drawn from NEMA statistical surveys and are adjusted for inflation and seasonal fluctuations.

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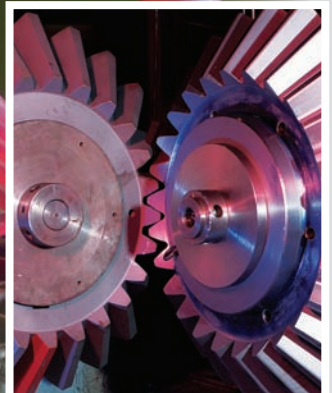
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