

# Power Transmission Engineering®

DECEMBER 2012

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### Technical

- [ ATEX-Approved Couplings ]
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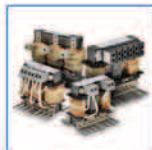
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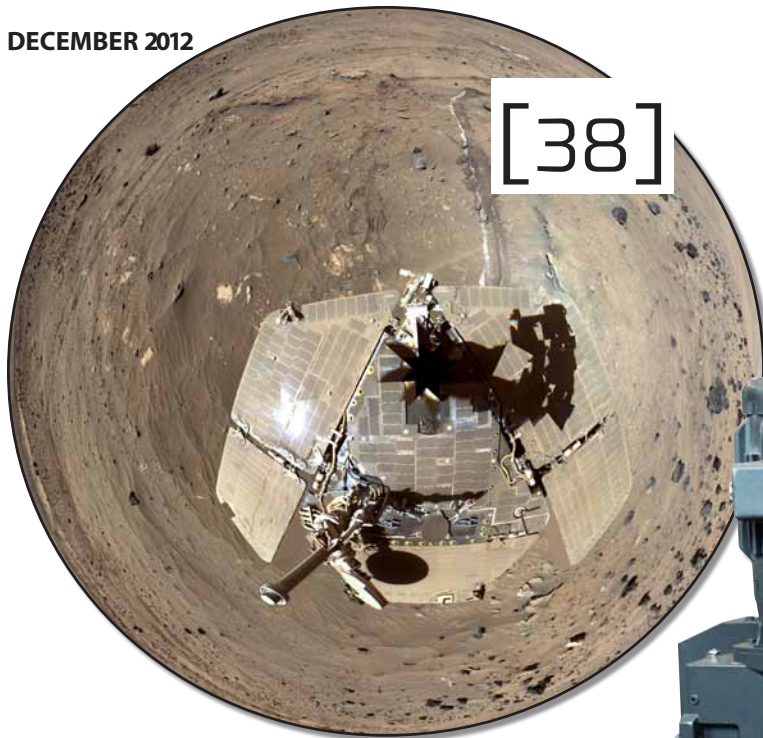


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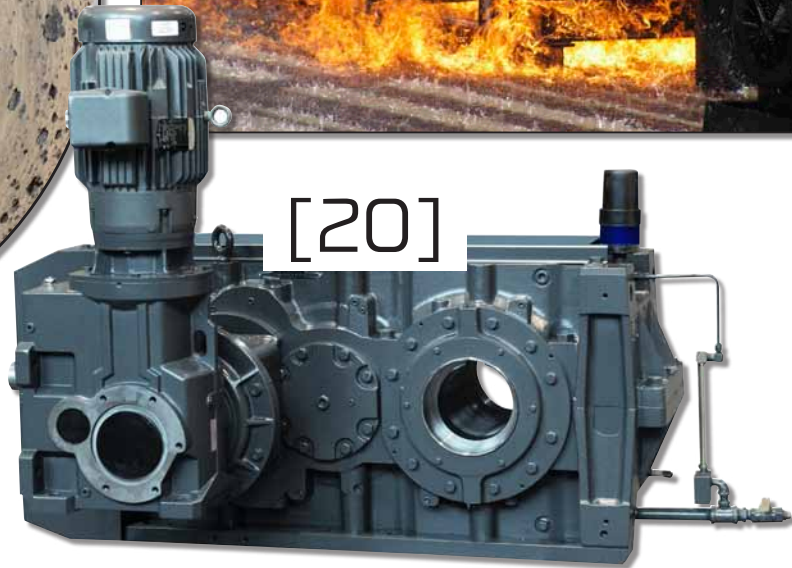
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## Drive Shaft Alignment

Representatives from Diamond Chain and Motion Industries demonstrate the basic principles behind drive-shaft alignment for chain-and-sprocket drives.

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## Hydraulic Motor Video Demo

Explore the operating principles of the Hågglunds hydraulic motor from Bosch Rexroth in this video showing cutaway views of the inner workings of the device, which is suitable for many heavy-duty applications.

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## New Additions and Updates

The following companies have recently added premium listings or updated their listings on [powertransmission.com](http://powertransmission.com). For the most current and up-to-date directory of mechanical power transmission component suppliers, visit [www.powertransmission.com/directory/](http://www.powertransmission.com/directory/)

## Sumitomo Drive Technologies

Sumitomo Drive Technologies is a business division of Sumitomo Heavy Industries (SHI), one of the largest manufacturers of machinery in Japan, and the global leader in power transmission knowledge and innovation.

## Dunkermotor advanced motion solutions

Headquartered in Elgin, Illinois, Dunkermotor is the North American sales, technical support and logistics subsidiary of Dunkermotoren GmbH, for 60 years the global quality and value leader in customized, configurable sole-source fractional horsepower motion control solutions.



Cabat Inc. located in Racine, WI manufactures a variety of dependable and precise overload/torque limiting release clutches.

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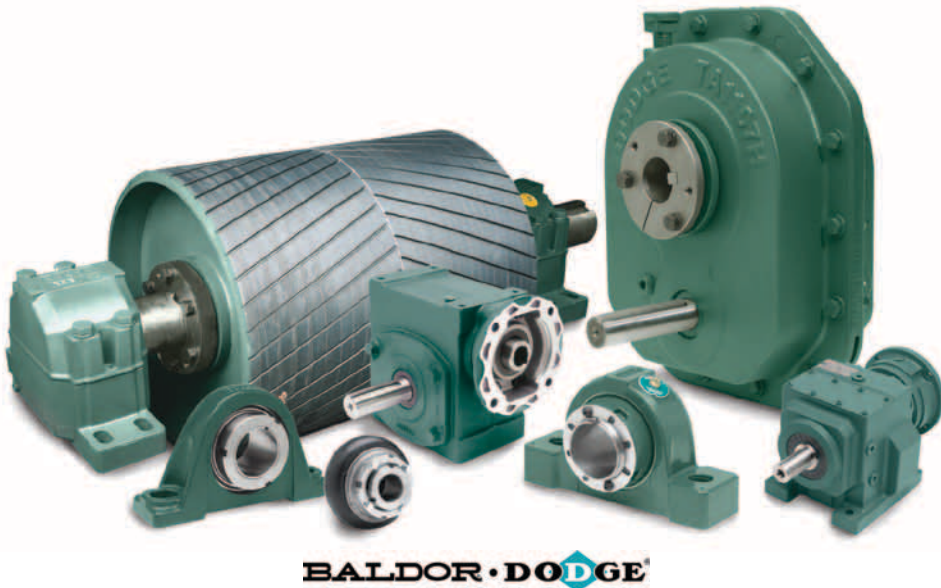
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# Ron Popeil Would Be Proud

**Every year at Christmas, someone in my family receives a gag gift.** The more gimmicky and ridiculous the item, the better the joke. Over the years, a number of such items have been gifted and re-gifted so many times that they're now ensconced in family lore. For example, we had an FM-radio/toilet paper holder that made the rounds for several years—until one of my uncles decided to actually install it (much to my aunt's dismay).

But without question, the best of these gifts, and my personal favorite—is the Egg Scrambler, a vintage “As Seen on TV” marvel, made by Ronco in the 1970s. We've been trading it back and forth for as long as I can remember.

The Egg Scrambler is sheer engineering genius. A tiny, bent wire pokes a hole in the egg. A motor spins the wire, and—voila—the egg is scrambled inside the shell. No need for bowls or whisks. Just crack it in the frying pan and you're good to go.

Mind you, I've never actually seen whether the Egg Scrambler works. No one in our family has. You see, our Egg Scrambler has never been used. It's still in its original box, wrapped in Cellophane. I think that's part of its appeal. But Ronco has sold a lot of them over the years. In fact, you can still buy them today.

The reason I'm telling you about the Egg Scrambler is not so much to reminisce about childhood memories, but rather because it came to mind when I started thinking about this issue of the magazine—particularly our printed buyers guide. The Egg Scrambler never caught on like some of Ronco's other products—such as the Veg-O-Matic, but it was originally sold the same way, via the television infomercial.

You all know the schtick. Ron Popeil demonstrates the amazing Veg-O-Matic and all of its slicing and dicing wonders. You're already convinced you need one, when he asks, “How much would you pay for that? \$59.99? \$49.99? How about the low, low price

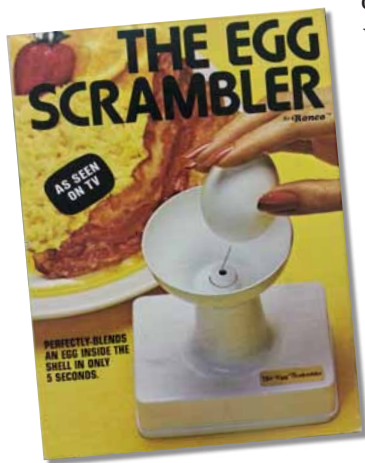


Image ©1978 Ronco Teleproducts, Inc.



of \$19.99?” And it sounds like a good deal, but he's got another sly trick up his sleeve, in the form of one of the most successful marketing catchphrases of all time: “But Wait! There's More!”

Our Buyers Guide is like that, too. We've compiled a comprehensive list of suppliers of mechanical power transmission components. You'll find their addresses, phone numbers and websites, all broken down by major product categories. I have no doubt that many of you who are buyers and specifiers of gears, bearings, motors, clutches, couplings, brakes and the like will find it an indispensable resource, which you'll refer to over and over throughout the year. And you don't even have to worry about how much you'd pay for it, because it's free.

But Wait! There's More! In fact, the printed buyers guide is only the beginning. Our online Buyers Guide, at [www.powertransmission.com](http://www.powertransmission.com), breaks down each product category into subcategories, so you can identify the exact suppliers you need for your mechanical power transmission needs. Plus, many of the top suppliers have premium listings online, which means you can also read detailed descriptions about each company's products and services, and you can contact those suppliers directly through the website.

Products like the Egg Scrambler and Veg-O-Matic were designed to save you time and money. And the same can be said of our Buyers Guide. Finding the right supplier can make all the difference in terms of making your products and/or operations more efficient, more productive, less expensive or of a higher quality.

And while I called the Egg Scrambler sheer engineering genius, the true engineering genius can be found right here in our pages. The Buyers Guide is filled with companies offering the most sophisticated technology available, manufactured to the highest standards. We hope you'll take advantage. **PTE**

*Randy Stott*

P.S. I'm pretty sure my sister got the Egg Scrambler last year. I'm guessing that when she has to give it to someone else, she'll be pretty sad. That's why I bought her a set of “Toastabags.” You put a slice of cheese between two pieces of bread in the Toastabag. Pop it in your toaster, and you get a grilled cheese sandwich in about a minute. No fuss. No mess. I can't wait to see the look on her face.



# From the Forest City Gear Family To You and Yours...Merry Christmas

During exceptionally busy years like this one we never truly stop thinking about our customers and their gear production challenges. Yet the holiday season reminds us of how blessed we are – for our family and team members, our industry and all our business associates.

From all of us at Forest City Gear: wishing you a very Merry Christmas and may your 2013 be a joyous and prosperous one.



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# It's All About the Cliff...

*...but, selectively speaking—still better long than short!*

Brian Langenberg, CFA

**We anticipate sluggish near-term growth** driven by inventory re-stock, improved residential housing and momentum in particular end markets—e.g. commercial aviation, resource extraction (coal and slowing natural gas) and power transmission and distribution.

**Elections have consequences.** Posturing was inevitable no matter who won, but decision makers will continue to sit on their hands until D.C. firmly establishes some ground rules regarding tax rates. Meanwhile, we are skeptical of any real improvement in the regulatory environment. If anything, we remain concerned about incremental employment growth (healthcare impact on service-oriented employment growth); availability of qualified labor (public schools: mostly bad; vocational training: not meeting need) and deteriorating infrastructure (roads, bridges, grid).

**At the moment the administration thinks, or is at least acting, like it has a mandate** for sharply higher taxes with little curtailment in spending. On the other side, Republican senate minority leader Mitch McConnell did not achieve his goal of making President Obama a one-term, but do recall that he *was* the guy who stood ground and rallied his party after 2008 when Democrats had the run of the table. It is delu-

sional to think he is going to back down this time around, either. The reality is that, for most people, “who is right” is linked to “how they voted.” Regardless—what is required now is a centrist approach with mutual compromise.

**The range of possible outcomes is considerable**—and on the road to reaching one we can count on much noise, carping and pundit-infused bloviating from all of the news outlets—with one’s political leanings dictating which of them hold our attention. But in the spirit of much-needed, reasoned discourse, here is our view of the range of scenarios:

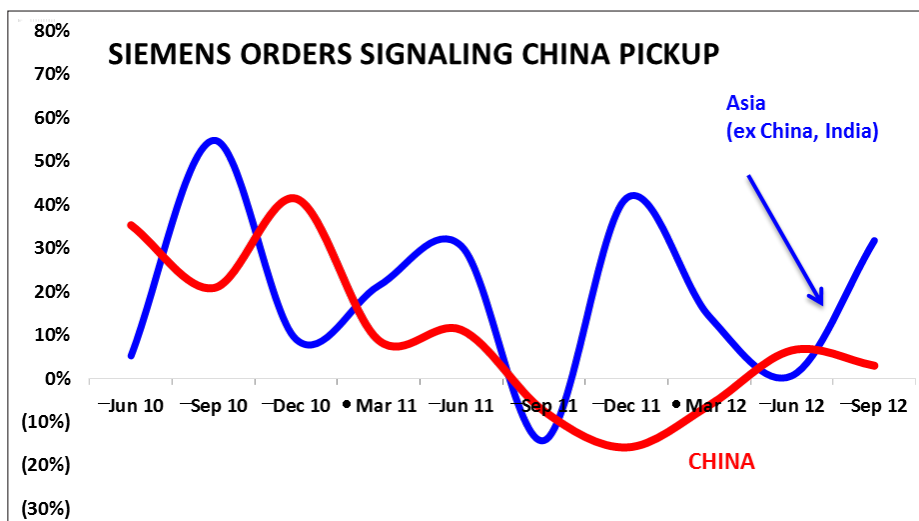
- **“Grand Bargain”: 1 percent probability.** This would be the smart way to do it, meaning of course it is DOA during a lame duck session. Such a deal would have three components: 1) lower corporate taxes (everyone agrees); 2) higher income tax revenue (Republicans are for reducing deductions, Democrats for higher rates); and 3) entitlement reform—i.e., raising retirement age, means testing benefits (which Dems are unwilling to negotiate).
- **Muddle through: 85% probability.** Extend most Bush-era tax cuts—along with payroll tax relief—and borrow more while hammering out a real budget. This is the easiest

(read: most politically expedient) thing to do and thus the most likely.

- **A Republican rollover: 1% probability.** This is not going to happen; McConnell will see to it because the last election was not a mandate for more government. Tea Party and religious conservatives are the party base and nearly half the electorate. Senior Republican leadership (often an oxymoron) will focus on two achievable goals: 1) fixing the immigration position; and 2) ditto the Repubs’ senatorial candidate vetting process. Both will involve educating, and some accommodation with, its base.
- **Thelma & Louise, a.k.a. Fiscal Cliff: 13 percent probability.** This... can happen. And... the odds have increased since November sixth. It does not matter what I think should happen nor what you think should happen. It also doesn’t matter what the media, CEOs or Europe think. What *does* matter in this scenario are the goals, agenda and political calculations of just a few players.

**We do expect a deal providing sufficient clarity for business decisions to be made.** Will such a deal be perfect or enough to deal with long-term issues? As we said, a “Grand Bargain” probability is 1 percent at best in the near-term. But as long as some sort of palatable deal is brokered there is reason for optimism. That said—and assuming some kind of deal is cut...

**China is positioned to accelerate in second-half 2013.** The drivers are pretty clear. After putting on the brakes in 2011-2012 to deal with rampant inflation and real estate speculation, coupled with an unusually public and tense “transition year” with respect to leadership, we expect China to step on the gas. We do not take the view that China can, or will, drive the global economy, but it remains a major component. Certain pieces are already in place; easy comparisons—signals that increased raw material purchases—are anticipated and a new political leadership team eager to come out of





the blocks fast and secure power will lead to a growth-oriented agenda.

**European exporters would benefit.** Even a modest tailwind for motors, drives, and power-related infrastructure could do wonders for the margins of a range of companies and we anticipate China picking up will help.

**Signs of improvement already exist.** Part of the client work we do here is monitor and analyze key data from over 55 global industrial companies. Several provide regional order detail and, as shown above, the Siemens order patterns are suggesting we are, at worst, in only a lull.

**The U.S. economy should continue to improve, albeit gradually.** Housing and automotive demand continues to rise. In particular, residential housing growth is slated to grow 11-13 percent for the next couple of years—well below historical norms but consistent with a weak recovery. And though improving home prices could prove to accelerate a turnaround, we suspect the length and depth of this most recent downturn has materially impacted societal views about leverage, debt and home price appreciation for at least the next few years. Still – it's enough to drive continued higher demand for construction/rental equipment and at least maintenance capital spending. Barriers to faster growth remain, as whatever combination of spending cuts and tax increases will serve as a headwind.

The rest of Asia a good leading indicator on China industrial activity and, as noted, the last quarter pick-up in orders suggests that at least modest gains are in our near future. While construction equipment demand will be down for at least 2-3 quarters (we think 3-5), we note that process automation never slowed and we anticipate a pick-up in industrial automation (motors, drives), construction-related (low-, medium-voltage) and transportation infrastructure (rail). We think this will serve as a catalyst for not only direct Asian demand but also as a catalyst for

S&P 500:		1386.4				
S&P 500 Earnings						
P/E	\$93	\$105	\$112	Price Return		
14x	1,302	1,470	1,568	(6%)	6%	13%
15x	1,395	1,575	1,680	1%	14%	21%
16x	1,488	1,680	1,792	7%	21%	29%
17x	1,581	1,785	1,904	14%	29%	37%
18x	1,674	1,890	2,016	21%	36%	45%
SKY IS FALLING			S&P 500	Impl. Ret.		
5/6/09 Armaggedon			683.38	(51)%		
8/19/11 US Downgrade			1123.5	(19)%		
% Prob.						
1%		Grand Bargain - lower corporate, < loop holes.				
85%		Short-term deal, argue in 2H13				
1%		Obama Steamrolls Mitch McConnell on taxes				
13%		Fiscal Pothole				
100%						

European exporters of heavier capital equipment.

**In our view, the markets implicitly assume a “muddle through” agreement.** Should we slide well past the New Year without a deal, I suspect markets would start to react in a very material way.

Consensus estimates for the S&P 500 Index are about \$102 in 2012 and \$112 in 2013. However, given estimate revision trends (down) and common sense (acquired via the tread marks on my back from being in the business for 24 years) we will plug in \$105.

In our view, there is a high likelihood of positive returns (pick your flavor as to magnitude) as long as earnings come through and the market P/E holds at about 14X.

There is a small likelihood—but potentially *very painful*—if it occurred—of *significant* declines.

How significant? Let's eliminate the guesswork and ponder the two worst downdrafts in the past five years:

1. The 2009 low (- 51 percent)
2. The downgrade of the U.S. by S&P in 2011 (-19 percent)

My sense is that—should we find ourselves come January in “full-cliff,”

extended-free-fall mode—and resulting full recession—that “down” could mean a realistically achievable 20 percent slide. Like most participants in the market, I do not think it will happen.

**And so, better long than short—but, selectively.** Our institutional and high-net-worth investor clients know where we stand; i.e.—only on to between hold and those things in which their intrinsic value means you are being “paid to wait” (e.g., General Electric, Tyco International). Or, for those who must be invested, we point also to United Technologies and Dover Corporation as offering “market-plus” returns. **PTE**

#### Brian K. Langenberg, CFA,

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



# Renishaw

OFFERS ENCODERS FOR WIND TURBINE BEARINGS

Blade pitch adjustment is one of the most critical functions of wind turbine operation, and the giant bearings in the adjustment mechanism can now be manufactured with accuracy typically reserved for small parts, using a new vertical turn/grind machine from Swedish builder KMT Lidsköping. The machine combines advanced motion systems with Renishaw optical and magnetic linear and angle encoders on critical axes to achieve form deviation of less than  $1\text{ }\mu\text{m}$  on parts 4,000 mm in diameter.

"This is hard turning and grinding, and is very demanding," said Eive Johansson, KMT Lidsköping's chief designer. "Positioning accuracy is very important, with a direct effect on the quality of the finished bearings." Prior to the VTG4000, the company's largest machine could accommodate parts up to 600 mm (24 in.) diameter, but the VTG4000 handles diameters in excess of 4,000 mm (157 in.), the size of the largest wind turbine bearings, while providing much greater accuracy.

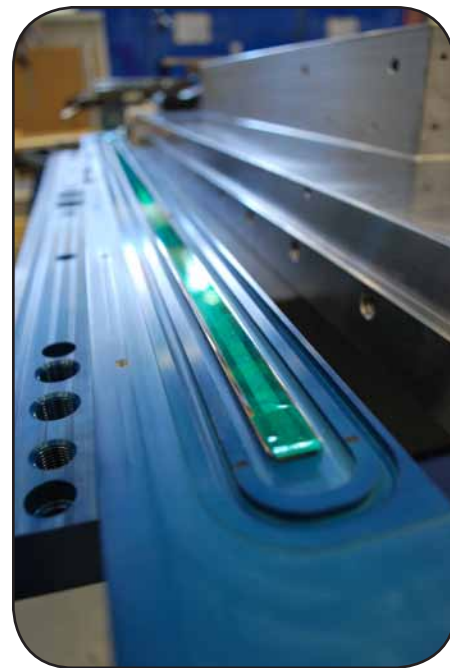
Linear motors on the linear axes make the VTG4000 fast, and firm hydrostatic guideways increase accuracy. "A standard size machine, using ballscrews on the axes, maintains about a  $3\text{ }\mu\text{m}$  form deviation," said Johansson. "This machine maintains form deviation of less than  $1\text{ }\mu\text{m}$  with

feed resolution in  $0.1\text{ }\mu\text{m}$  steps." Linear slides are at the heart of Lidsköping machines, and the combination of hydrostatic guideways, air seals and linear motors creates a stiff, accurate, maintenance-free system. "To achieve dynamic stiffness we need high gain, which is linked to the quality of the encoder scales," explained Johansson. "It also makes a big difference that the angle encoders have the scale integrated directly onto the ring."

## High Quality Improves Control of Turbine Blades

Pitch bearings allow wind turbine blades to optimize their angle according to wind speed, or create a stall condition in high winds, so the reliability of these bearings is critical to efficient, safe operation.

The multi-tasking VTG4000 is designed to machine these large bearings in a single set up, performing both turning and grinding with two separate heads. The two heads are configured as required, usually grinding/turning or grinding/grinding. The machine's 4.5 m X-axis carries the two heads on opposite sides of the part, and allows both grinding and turning tools to access the outside of the part. With some components weighing more than 35 tonnes, the VTG4000 is very resistant to distortion and thermal variation,



which is aided by closely controlled hydrostatic oil and coolant temperatures. "We've used hydrostatic guideways since the 1970's, and combining them with linear motors gives us a faster, more accurate machine capable of far greater acceleration and deceleration," said plant manager Henrik Jonsson. "When you see that you can move the 25,000 kg rotary axis with your finger, you realize how good the hydrostatic system is."

Johansson first saw the encoders that would end up on the VTG4000 at the EMO show in 2007, and Lidsköping put the sensors through rigorous testing. "We compared different scales assembled on our reference slide and selected the one with the best performance," said Johansson. "It was important that the linear encoders have a continuous length of at least 4.5 m, as well as high dirt resistance, and SiGNUM fit these requirements the best. We have fitted them to all four linear slides, and have had no problems. Our rotary table has the same design principle, with hydrostatic radial and axial bearings, air seals and torque motors. We did the same analysis and chose the SiGNUM angle encoders."

Renishaw's LM10 magnetic angle encoders are fitted to the B-axes of the grinding heads. These encoders are exposed to the harsh conditions of the machine environment, but their







non-contact, non-optical design, and sealing to IP68, protects them from the effects of coolant and swarf. The digital or analog output LM10 allows up to 100 m travel and high-speed operation of up to 25 m/s (4 m/s at 1  $\mu$ m resolution).

All Renishaw encoders feature an integral patented set-up LED that speeds installation and removes the need for complex set-up equipment or oscilloscopes. "One of the best features of the Renishaw encoders is how easy they are to set up," added Johnasson. "With the scale attached and the readhead approximately located, the indicator lights make it very easy to see how well the two elements are aligned."

To accurately set the part in the machine's work-coordinate system, the VTG4000 uses a Renishaw RMP60 radio signal transmission touch probe. After a raw part is placed on the bed, the RMP60 is loaded into the tool changer and used to locate the exact position of key features in a matter of seconds. This data is used to update the coordinate system in-cycle for quick, accurate machining.

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# Kollmorgen

DELIVERS COMPONENTS FOR ELECTRIC MOTORCYCLE

VT BOLT, Virginia Tech University's entry to the 2012 all-electric TTXGP is a 100 percent electric racing motorcycle driven by a low-voltage Kollmorgen AKM 74 AC permanent magnet motor and a Kollmorgen ACS80XL 80V Gen6 drive. The results have been impressive, with the AKM motor and ACS drive enabling VT BOLT to achieve

top speeds in excess of 100 mph with consistently high performance throughout



the duration of each approximately 20-mile race using a 7.5 kilowatt hour battery pack. The VT BOLT was a recent first place winner of all three of its TTX75-cup races including Portland International Raceway, Laguna Seca Raceway and Miller Raceway, solidifying VT BOLT as the 2012 North American TTX75 Cup winner.

Virginia Tech's BOLT was designed to compete in the 75-class (7.5 kWh energy storage) motorcycle division. The idea was to develop a 100 percent electric motorcycle that could perform as fast as possible, while optimizing the energy stored in the battery to achieve maximum performance throughout each race. It also required just the right balance of torque and speed to accommodate the numerous turns common to GP racetracks, but without over-consuming power and compromising performance at the end of each race. Virginia Tech not only had to under-

stand the technology, they needed to integrate the technology into a purpose-built racing machine. The VT BOLT design team turned to Kollmorgen for help and sponsorship.

"Kollmorgen's standard technology platforms are ideal for a wide variety of high-performance applications in that they are easily customized to meet the specific needs of a particular application, and the VT BOLT project was no exception," says Brad Monday, design engineer for vehicle systems, Kollmorgen. "We not only helped the VT BOLT team identify and integrate components into an optimized system, but with our sophisticated application support we were able to provide insight into how VT BOLT would perform on the track before it was built."

Kollmorgen worked with the team at Virginia Tech to identify the optimum drive/motor/gearing system that would enable VT BOLT to leverage the available power of the battery pack to deliver the best performance in terms of consumption and speed, ultimately specifying a Kollmorgen AKM motor and ACS drive.

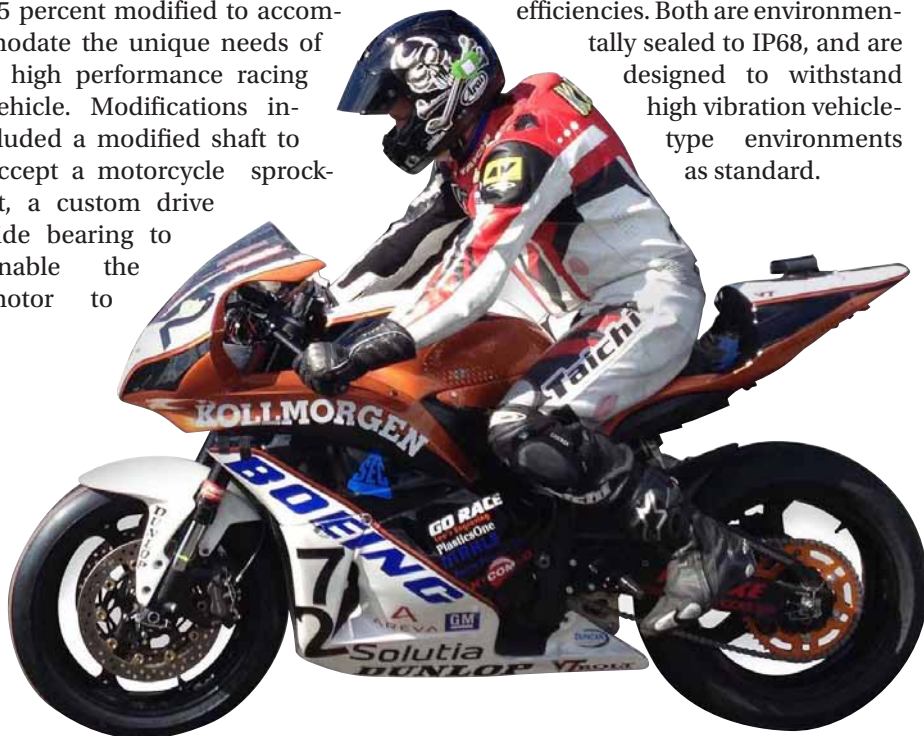
According to Monday, the AKM74 motor was 75 percent standard and 25 percent modified to accommodate the unique needs of a high performance racing vehicle. Modifications included a modified shaft to accept a motorcycle sprocket, a custom drive side bearing to enable the motor to

withstand the radial loads exerted on the shaft by the chain, and a modified motor winding to operate at the low voltage required by the 7.5 kWh battery pack.

The ACS80 is a 40 kW, or 54 hp, drive as standard. Kollmorgen delimited the drive for the VT BOLT application to enable higher power output (57.6 kW or 77.2 hp) for the shorter duty cycle and duration of the racing environment. Monday says that the Kollmorgen ACS80XL 80V Gen6 drive was a perfect fit for VT BOLT because the capabilities needed to deliver the desired performance were inherent in the drive.

"The particular ACS drive used in the VT BOLT motorcycle is commonly used in 4-5 ton forklift vehicles to control traction. For VT BOLT we simply modified the drive interface to accept this application and programmed it to formulate speed, throttle and power regeneration for braking, while also coordinating the rider interfaces through the drive," explains Monday. "Other drives in the ACS family are often used to control steering wheels and brakes, operate hydraulic pumps and perform overall vehicle control; ACS drives are fundamentally flexible enough to be used in an assortment of applications."

The AKM motor provides mid-ninety percent efficiencies and the ACS drive provides high-ninety percent efficiencies. Both are environmentally sealed to IP68, and are designed to withstand high vibration vehicle-type environments as standard.





The motor and controller convert DC power from the battery pack to AC power for the motor. The motor then takes the AC power and converts it to torque and speed to power the motorcycle's drivetrain. The drivetrain consists of two gears and a chain which are connected to the rear wheel of the motorcycle.

"This project was just a lot of fun from start to finish for everyone involved," says Monday. "It was a great opportunity to work with engineering students and to push the limits and boundaries of products to achieve high performance in a unique application. Additionally we get to share the finished product with Kollmorgen associated back at the plant to see and enjoy firsthand."

#### For more information:

Kollmorgen  
203A West Rock Road  
Radford, VA 24141  
Phone: (540) 633-3545  
[www.kollmorgen.com](http://www.kollmorgen.com)

## Smalley Steel

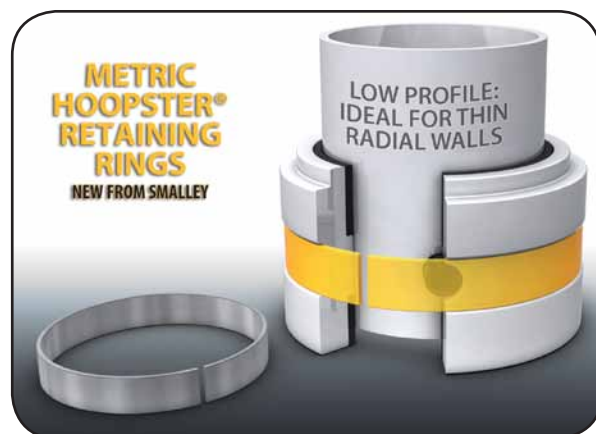
OFFERS METRIC HOOPSTER RETAINING RINGS

Smalley Steel Ring Company recently announced the launch of the new Metric Hoopster retaining rings. The new Metric Hoopster retaining rings offer an innovative way to retain mechanical components when space is a problem. The Hoopster's minimal radial projection and shallow groove depth allows the Hoopster to fit where regular stamped rings and retaining rings cannot. The Hoopster's low-profile, precision circularity and small radial size allow it to be an unobtrusive component in an assembly. Hoopster retaining rings are suitable for light to heavy loads and are ideal for thin wall tubes. An additional advantage of the Hoopster is its potential for high thrust capacity. The low radial profile will not twist or deform under load as with conventional retaining rings. As an extension to Smalley's popular Hoopster Retaining Rings, the new metric series offers engineers added design flexibility. Over 150 new rings are available from 10mm to 76mm in carbon and 302 stainless steel. Hoopster retaining rings are easy to install and remove

without any special tools. Specials can be made with no-tooling-charges. Internal housing rings are available with an optional bent end (removal provision) to simplify the process.

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## Stober Drives

INTRODUCES EZF SERVOMOTOR

Stober Drives, Inc. of Maysville, Kentucky has introduced its EZF/PY hollow-bore pipe drive into its new product line. Only a few manufacturers in the world manufacture a similar product. The hollow bore servomotor ranges from a zero to 3,000rpm output speed and 4.2Nm to 350Nm stall torque. It features an inside diameter ranging from 28 to 42 mm. The EZF is particularly well-suited for the packaging, printing, general automation, robotics and machine tool industries.

"The EZF-PY servomotor conforms to the high standards we set to continue Stober's heritage of delivering gold-standard products and exceptional service," said Peter Feil, vice president at Stober's Maysville, Kentucky plant. "The EZF will help customers substantially reduce their total cost of operations."

The gear motor eliminates the need for a right angle drive when space is critical, adding increased performance and lowering costs, said Adam Mellenkamp, product manager at Stober.

"The configuration has a hollow shaft that allows for power cables, air cables, data lines and laser beams to

length: as small as 134mm. "Everyone knows of a time when they could have used this gear motor," said Mellenkamp. "This product fills a needed niche in motion control."

The EZF/PY provides industrial implementation of tooth-winding using orthocyclic linear winding technology. This feature makes it possible to manufacture the stator windings with the highest possible copper fill factor. The winding technology increases the motor power output by approximately 80 percent; for this reason it is possible to shorten the length of the motor by almost half without reducing power output.

An advantage of the motor is that it is thermally protected by a positive temperature coefficient (PTC) in each phase of production. PTC in the EZF/PY ensures that electrical resistance increases when outside temperature increases. Once the PTC reaches a certain temperature (145 degrees C.), the monitoring system activates to protect the motor winding from heat damage. A KTY-84 temperature sensor is also available.

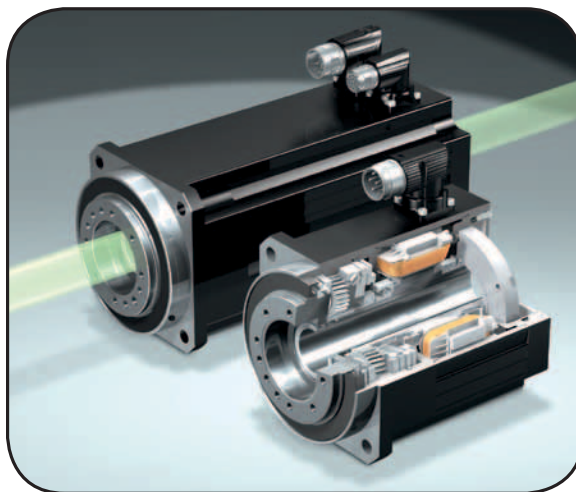
The PY also has water or forced-air cooling for a higher-rated power at high ambient temperatures, allowing for a 35 percent torque increase. A fan can be added in the field. Due to its weight-saving design, the pipe drive is particularly suitable for applications in which the motor itself is part of a moving axis.

Rotatable connectors allow for easy connection and cable routing. The motor also features an optional magnetic brake for holding static loads. The brake is engaged when the power is off. The servomotor is designed to

run with most popular servo drives. Stober offers support and sizing recommendations to make proper selections.

### For more information:

Stober Drives, Inc.  
1781 Downing Dr.  
Maysville, KY 41056  
Phone: (800) 711-3588  
[www.stober.com](http://www.stober.com)



get through the center of the motor," said Mellenkamp. "You can even use liquid cooling to increase torque capacity of the unit. This is our way of helping manufacturers become cleverer, leaner and utilize fewer parts."

The servomotor comes in frame sizes 5 (115mm square) and 7 (145mm square)—and an extremely short

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pling is critical when making a selection. Rigid couplings have high torque capacity, torsional stiffness, and are zero backlash. Ruland straight bore rigid couplings have precision honed bores for proper fit and alignment. Proprietary Nypatch coating is used on hardware to resist vibration and maintain holding power. Two-piece styles feature opposing screws for balancing, reducing vibration at higher speeds. Ruland rigid couplings are available in carbon steel for highest torque capabilities, aluminum for low inertia, and stainless steel for corrosion resistance. Inch, metric, and inch to metric sizes are available with or without keyways from 1/8 in. to 2 in. and 3 mm to 50 mm.

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Ruland Manufacturing Co., Inc.  
6 Hayes Memorial Drive  
Marlborough, MA 01752  
Phone: (508) 485-1000  
[www.ruland.com](http://www.ruland.com)

# Mitsubishi Electric

UPGRADES INVERTER RANGE

Mitsubishi Electric has upgraded the FR-F700-EC range of inverters with a number of functions that meet the specific needs of water and pumping applications. The new functions supported by the upgrade include a pre-charge function, built-in PLC functionality, expandable I/O and a unit calculator for PID control. These enhancements increase the capability, flexibility and scope of the FR-F700-EC, bringing improved control and reducing the cost and complexity of drive installations in many applications by eliminating the need for additional components.

A key issue within many pumping applications is water hammer – the pressure surge that can occur when the flow of water starts or stops suddenly. Aside from the noise of water hammer, the vibration can quickly compromise system life and ultimately lead to break down of pipeline systems. The new pre-charge function eliminates the problem of water hammer and extends system life by gradually filling the pipeline. Flexible adjustment options enable the end of the pre-charge cycle to be controlled by feedback level, terminal input or set time. The FR-F700-EC now also includes built-in PLC functionality, suiting the drive to standalone use in pumping and water applications and eliminating the need for a separate PLC for sequence control operations. The built-in PLC offers a program capacity of 4,000 steps, and the PLC function supports 32-bit instructions to handle 32-bit data. The inclusion of two option ports on the drive enables the I/O to be expanded with analogue and digital inputs and outputs, as well as relay outputs. This

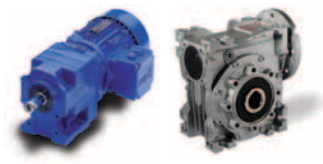


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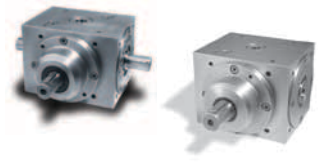
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enhanced I/O can be used to provide feedback inputs for the PLC and control outputs to valves and other components. For enhanced security in the field, the program can be password protected.

The new control keypad supports the ability to display PID values in engineering units allowing for easier set up and monitoring. This is especially useful in pump and fan installations. There are actually 32 different unit settings available, for example, Pascal (Pa), liters per minute (L/M), cubic meters per minute (CM/M) or bar.

With these new functions Mitsubishi Electric has already addressed a number of applications within the pumping and water industry, for example an irrigation system where there were several pipelines of different heights and lengths, but only a single pump and pressure sensor. The built-in PLC function enabled six different PID set points to be stored, and then simply selected by a switch on the cabinet door, providing a simple solution in an application that might once have required substantial inverter and PLC knowhow.

#### For more information:

Mitsubishi Electric  
5900 A Katella Avenue  
Cypress, CA 90630  
Phone: (714) 220-2500  
[www.mitsubishielectric-usa.com](http://www.mitsubishielectric-usa.com)

## Automation Direct

### RELEASES SURESTEP DUAL-SHAFT MOTORS

AutomationDirect has expanded the line of SureStep motion control products. Stepping motors in standard NEMA sizes (17, 23 & 34) now include dual-shaft, bi-polar models with output torques ranging from 61 oz-in. to 1288 oz-in. The motors feature front and rear shafts to allow installation of an encoder, hand crank or a second load



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onto a motor; a pigtail cable with locking connector allows for easy hook-up. The motors travel 1.8 degrees per step, providing 200 steps per revolution. Backed with a one-year warranty, the stepping motors are CE- and RoHS-compliant and prices start at \$22. The SureStep motors can be controlled by SureStep microstepping drives, programmed with *SureStep Pro* software.

#### For more information:

AutomationDirect  
3505 Hutchinson Road  
Cumming, GA 30040  
Phone: (770) 889-2858  
[www.automationdirect.com](http://www.automationdirect.com)

## Sumitomo

### INTRODUCES MOBILE APPLICATION

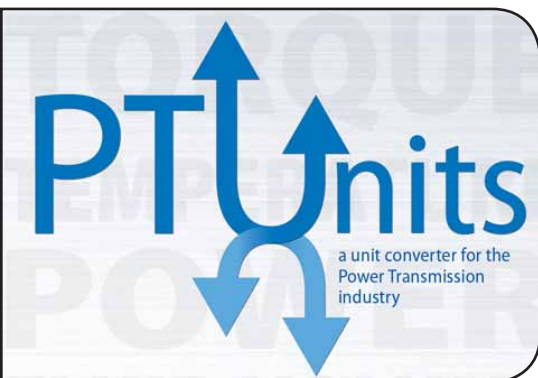
Sumitomo Machinery Corporation of America (SMA), U.S. headquarters for Sumitomo Drive Technologies, introduces PT Units, a new Power Transmission Industry mobile application for the iPhone, iPad and iPod Touch. PT Units offers three main functions: converting units, contacting Sumitomo Drive Technologies representatives

and connecting to Sumitomo's web resources. The unit converter quickly and accurately converts between commonly used units of power, torque, force, temperature, fluid volume, mass and length. Additional options available in this function include copying the resulting conversion text and pasting it into other applications, and setting the default units upon launching PT Units. The contact function enables users to locate a Sumitomo Drive Technologies' sales representative by navigating to find their location, or using their device's built in Current Location feature to obtain the representa-

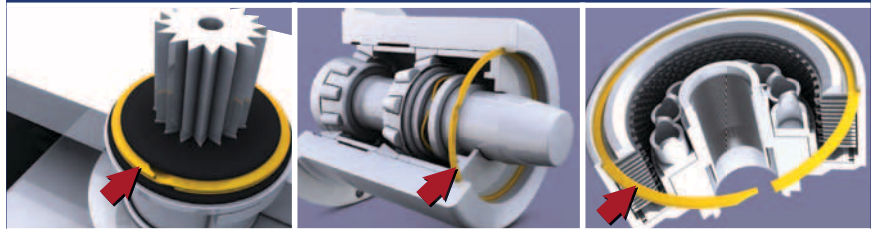
tive's contact information. With a data network connection, this information is available for USA, Canada, Mexico, Central America, Caribbean Islands, South America and Japan. This function also enables iPhone users to contact a Customer Service representative via phone or email, and iPod Touch and iPad users via E-mail. The website function allows users with a data network connection to navigate through Sumitomo Drive Technologies' website for product information, industry-

#### For more information:

Sumitomo Machinery Corp.  
4200 Holland Blvd.  
Chesapeake, VA 23323  
Phone: (757) 485-8218  
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and connecting to Sumitomo's web resources. The unit converter quickly and accurately converts between commonly used units of power, torque, force, temperature, fluid volume, mass and length. Additional options available in this function include copying the resulting conversion text and pasting it into other applications, and setting the default units upon launching PT Units. The contact function enables users to locate a Sumitomo Drive Technologies' sales representative by navigating to find their location, or using their device's built in Current Location feature to obtain the representa-



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Steinmeyer, Inc. announced a new high precision micro stage, the MT 196LM series. Available in two travel options, of either 100 mm or 200 mm, the MT196-100-2LM and the MT196-200-2LM is suitable for applications in the semiconductor metrology, bio-medical, miniature robotics and laser

industry. The MT196LM has a footprint of 110 mm × 196 mm, height of 45 mm and, depending on which stage you choose, weighs 4.1 or 4.7 kgs. Manufactured from high strength anodized aluminum, this series of table offers a positional accuracy of 2 μm (micrometer), straightness/flatness runout of

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# The Fundamentals of Specifying and Selecting Gear Drives

By Adam Tietyen and Jason Quackenbush  
(Reprinted with permission from *CPSA Journal*)

## Introduction

Gear drives deliver power to industrial equipment such as bulk material conveyors, mixers, pumps and paper mills. The reliability that translates into greater uptime and profitability begins by specifying and selecting the proper drives for these critical applications. Many variables—such as service factor, gear drive rating, thermal capacity, speed variation and drive ratio—must be considered when sizing and selecting a gear drive. In addition, specific drive features may provide value-added benefits such as cooler operation or ease of serviceability that help reduce total cost of ownership over the life of the drive—a win for any organization. Here are several major areas of im-

portance to consider when selecting a gear drive.

## Service Factor

The service factor (SF), a variable that combines external load dynamics, reliability and life, is used to calculate equivalent horsepower. Application and service duty play an intricate role in determining the proper service factor. Acceptable values of SF are determined by field experience. The American National Standards Institute (ANSI)/American Gear Manufacturers Association (AGMA) Standard 6013-A06 (Metric 6113-A06) for enclosed speed reducers publishes a listing of applications with their recommended service factors.

Once an SF is chosen, the factor is multiplied by the motor nameplate power to establish the size of drive required by the equipment to be driven. A higher SF—or larger gear drive size—should be selected when peak running loads are substantially greater than normal operating loads.

Gear drives that are supplied in combination with electric motors may be designated with a service class number such as I, II or III, rather

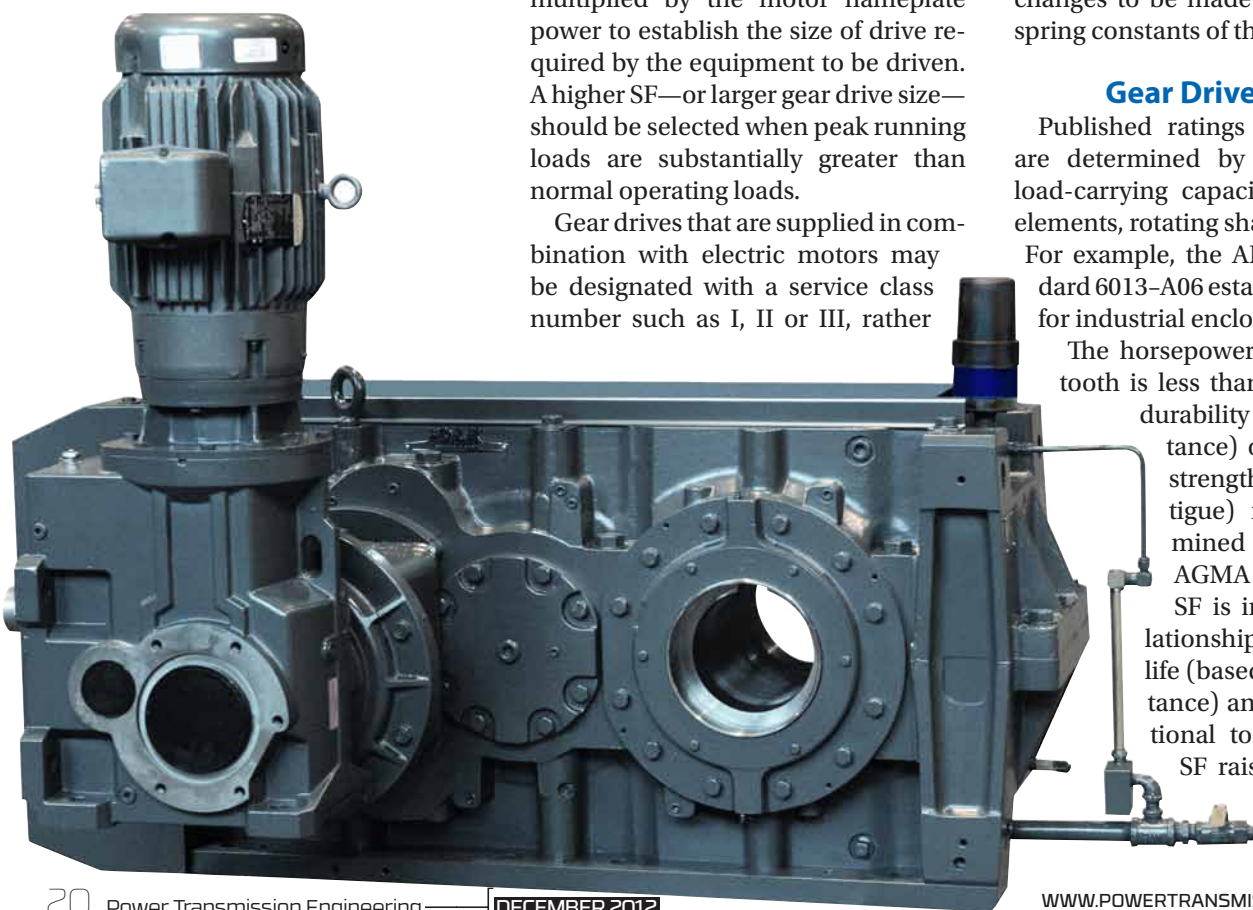
than a numerical SF. Classes I, II or III are equivalent to SF values of 1.0, 1.41 or 2.0. Service class and service factor are used interchangeably; however, numerical designations are preferred because service class does not accommodate intermediate SF values.

Note that published service factors are only the *minimum* recommended for a given application. Applications involving unusual or severe loading, or those requiring a higher degree of dependability, should be reviewed with the drive manufacturer. Typical values of SF will not accommodate systems that have serious, critical vibrations or repetitive shock loading. The system designer must identify vibratory or shock loading prior to gear drive selection. These conditions will require changes to be made in the inertia or spring constants of the drive system.

## Gear Drive Rating

Published ratings of a gear drive are determined by the mechanical load-carrying capacity of gear tooth elements, rotating shafts and bearings. For example, the ANSI/AGMA Standard 6013-A06 establishes standards for industrial enclosed gear drives.

The horsepower rating of a gear tooth is less than or equal to the durability (pitting resistance) of the surface, or strength (bending fatigue) rating, as determined by established AGMA criteria. As the SF is increased, the relationship between gear life (based on pitting resistance) and load is proportional to the increase in SF raised to the 8.78th power. For ex-





ample, if SF is increased by 30 percent, the gear tooth life will increase 10 times.

Shafts support the gear tooth elements that transmit torque from the motor to the driven machine and also distribute the radial loads to the bearings. While shafts are designed for carrying torsional and bending stresses, they also minimize deflection by maintaining uniform contact across the gear face.

Roller bearings are selected according to bearing manufacturers' recommendations. Bearing life is defined as the number of hours of operation at a constant speed before the first evidence of fatigue develops on either the raceway or rolling elements.

### Determining Thermal Capacity

Checking the thermal capacity of a gear drive is extremely important to ensure desired drive performance. Manufacturers' catalogs list thermal horsepower ratings based on a continuous duty cycle at an ambient temperature of 68°F (20°C) and an altitude of up to 2,460 feet above sea level. For other conditions, the thermal horsepower rating must be multiplied by factors provided by the manufacturer for the specific drive under consideration.

The maximum acceptable temperature for an oil sump is 200°F (93°C), according to AGMA standards. However, some manufacturers recommend lower temperatures to increase service life of the lubricant and extend operating life. These temperatures can be achieved with design features that improve cooling, as well as with auxiliary cooling methods.

Thermal capacity can limit selection of a drive if it is less than the nameplate rating of the motor—unless auxiliary



cooling is provided. SF is not involved since heat dissipation is based upon average power consumed—not peak loads.

Gear drives are designed with a variety of internal features to minimize power losses, while yet assuring adequate splash lubrication. These include oil exclusion pans to reduce churning, wipers to collect oil from the rotating gear for distribution to the bearings, and dams to maintain a reservoir at the bearing. Sealing also is critical to dependability. Some manufacturers offer no-leak seals with purge-enabling grease chambers and contact seal designs that eliminate oil leaks while keeping dirt out.

If a gear drive generates heat faster than it can be dissipated, loss of operating life or severe damage can occur. This may take the form of surface distress on the gear teeth or hardening of the oil seals, resulting in leakage. Reducing operating temperatures will increase the oil film thickness at the gear teeth and bearings, thus increasing the life of the equipment.

Heat is generated by a gear drive through frictional loss. The gear lubricant is the carrier of this heat, which is then distributed to the housing and conducted to the outside surface, where it is dissipated. Housing design and configuration can improve heat dissipation.

If the thermal capacity of the gear drive is greater than the motor nameplate rating, and the ambient temperature is below 100°F (38°C), the operating sump temperature should remain below 93°C (200°F). If, on the other hand, the drive is in a confined area and is coated with dirt or waste material, a high probability of distress and a corresponding shorter operating life should be expected.

### Effect of Speed Variations

Variable speed applications fall into two load categories: constant torque or constant horsepower. Constant torque occurs when load demand varies proportionally with a change in speed. Gear drives are basically constant torque machines requiring no selection modifications. For a constant horsepower application (load demand is constant regardless of speed) the gear drive must be selected for the slowest speed at which the motor will deliver its rated horsepower capacity. This also applies when a mechanical, electrical or hydraulic speed reduction device is used between a gear drive and a constant-speed AC motor. Variable or multi-speed applications also require special considerations to provide adequate splash lubrication at the slowest speed, but without excessive heating or churning at the higher speed.

Manufacturers' catalogs list input speeds for the high-speed shaft of each type of drive. These generally are based on standard motor speeds. Any input speeds above these limits should be discussed with the manufacturer, as they may exceed the design capabilities of the drive.

### Finding the Ratio

To arrive at the specific gear ratio required, divide the motor full-load speed by the revolutions per minute (rpm) of the driven equipment. Exact ratios are determined by dividing the actual number of gear teeth by the mating pinion teeth—both of which are whole numbers. Deviation between AGMA nominal and exact ratios are  $\pm 3$  percent for a single-reduction gear drive, and  $\pm 4$  percent for a double-reduction. For applications with variable frequency drives, exact gear ratios become less important. In such cases it is best to select a manufacturer's standard ratios. These will provide lower costs and quicker delivery, with ready availability of off-the-shelf stock spare parts.

### Choosing the Right Size

Manufacturers' catalogs provide input speed, ratio and horsepower rating for use in determining the size of the drive. Other factors that should be considered include: type of unit; initial cost vs. cost of maintenance (total cost of ownership); useful operating life; and spare parts if a marginal selection is made. For example, a 30 percent increase in the initial cost of specifying a gear drive that is one frame size larger could easily represent a 240 percent greater bearing life and 10 times greater gear tooth life. One additional consideration is ease of serviceability. Some drives have a horizontal split

housing that makes them easier to disassemble and reassemble for maintenance of bearings and gearing.

Gear drives are available in a variety of sizes, with various shaft configurations to meet your space requirement. The most popular are parallel-shaft, concentric, and right-angle, with low-speed shaft either horizontal or vertical to the input shaft centerline. Some drives are available with special features such as backstops, which prevent reverse rotation. The manufacturer's selection procedure that applies to these features should be followed.

Under normal circumstances, reliability is evaluated as part of the SF, which accounts for the effect of the normal statistical distribution of failures found in material testing. Gear teeth designed to AGMA standards are based upon a statistical probability of less than one failure in 100. Most designers recognize that using a higher-than-minimum SF is cheap insurance compared to the costly downtime that results when a process is interrupted due to the failure of a single component. Because drive designs may vary considerably, past experience can only be a guide in determining the proper service factor for a new drive, and the manufacturer's recommendations should be followed.

Maintaining the proper level of oil in the sump, or a steady supply of cool, filtered lubricant, is basic to achieving long service life. To further increase thermal capacity, a shaft-driven fan can be mounted on the drive. This increases air flow along the exterior of the housing to improve heat dissipation. Cool operation also can be achieved through housing designs that improve this dissipation and ensure optimum bearing lubrication. Some manufacturers also offer optional cooling sys-

tems to control oil temperatures in the most extreme conditions.

Factors that can affect performance and wear, such as operation in an elevated temperature, can be managed with a consistent, preventive maintenance program followed by immediate corrective action. Manufacturers offer various condition monitoring packages to monitor bearing temperatures, vibration and other measurements, as well as convenient oil sampling ports that allow for lubrication analysis.

For specific details and rating information when researching a gear drive, always refer to the manufacturer's catalogs and technical support advisors to ensure that the drive you select will provide the optimum reliability, ease of service and uptime—with the lowest total cost of ownership. **PTE**

**Adam Tietyen**, director engineering—product commercialization at Rexnord, has more than 20 years of gear drive design, application and drive system experience. Tietyen is seasoned in gear and coupling applications engineering, with specialization in bulk material handling solutions. Recently he led new gear product engineering and commercialization activities for Rexnord, and currently leads the Rexnord mill products engineering team. Tietyen is a member of the American Gear Manufacturers Association (AGMA), the Society for Mining, Metallurgy, and Exploration (SME), and the Conveyor Equipment Manufacturers Association (CEMA).



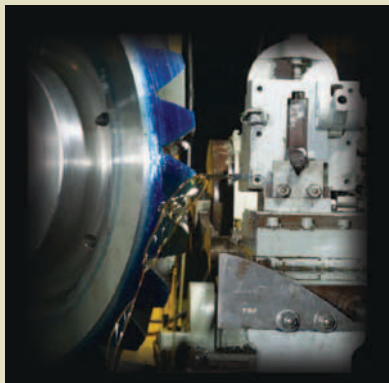
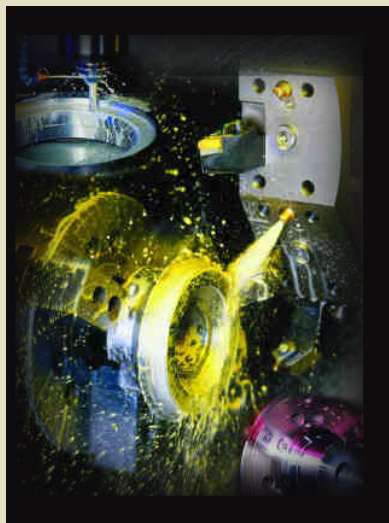
**Jason Quackenbush**, marketing manager—engineered drives at Rexnord, has 10 years of power transmission sales, marketing and system application experience. Jason's responsibilities have tied to Rexnord and Falk-branded gear with coupling applications specializing in bulk material handling solutions. Recently, he headed the commercialization activities for the launch of Rexnord's Falk V-Class product line. Quackenbush is a member of the SME.





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a speed-controlled system will make the system tend towards instability and much more complex to optimize tuning. The current or torque-regulated modes of control tend to be more stable over a wider range of conditions. When implementing the torque modes consider torque limiting with tension feedback if accuracy is important.

The mode of tension regulation via speed control is ideally implemented when the web is highly compliant or “extensible.” In this mode, the added system gain from additional control loop (speed controller) and transformation from force (load cell) to speed (speed loop) to torque (current loop) is a help in meeting the additional system demands.

**Drive-sizing.** In the engineering and design of web-handling drive systems the traditional practice is to optimize the drive and motor sizes as close as possible to the web power requirement. This is accomplished by selecting a mechanical gear ratio that will enable the motor to run as close as possible to its base speed in a web-transporting-driven section (non-winder), and well into the constant power range for center-driven wind or unwind (when an induction motor is used).

The optimum gear ratio is determined by:

- Optimum motor speed rpm/maximum load speed rpm

For a driven section with a fixed diameter roll, the power requirement is determined by the maximum torque requirement at maximum speed. The power requirements for a fixed-diameter transporting roll (sectional drive/pull roll) are from the following:

$$\text{maximum torque (lbf-in)} = (\text{driven roll diameter [in.]} / 2) * \text{maximum web tension [lb.]} / (\text{gear ratio} * \text{gearing efficiency})$$

$$\text{maximum speed (rpm)} = \text{maximum web speed fpm} / (\pi * \text{driven roll diameter [in.]} / 12) * \text{gear ratio}$$

The work done by center-driven winds or unwinds is constant power. The torque and speed requirements change throughout the building of the roll. Torque is highest at full roll, with speed the lowest. At the core or smallest diameter, speed is highest and torque is lowest. We can consider the following as the main sizing criteria for a center-driven unwind or rewind:

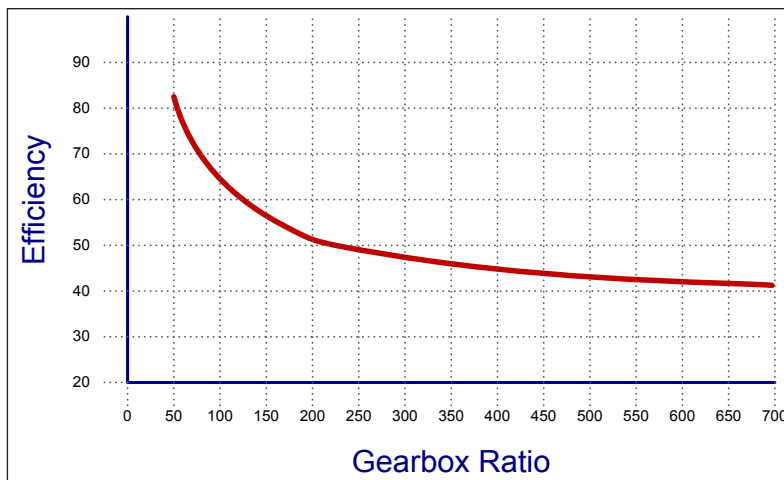


Figure 4 Typical multistage high-ratio gearbox efficiency.

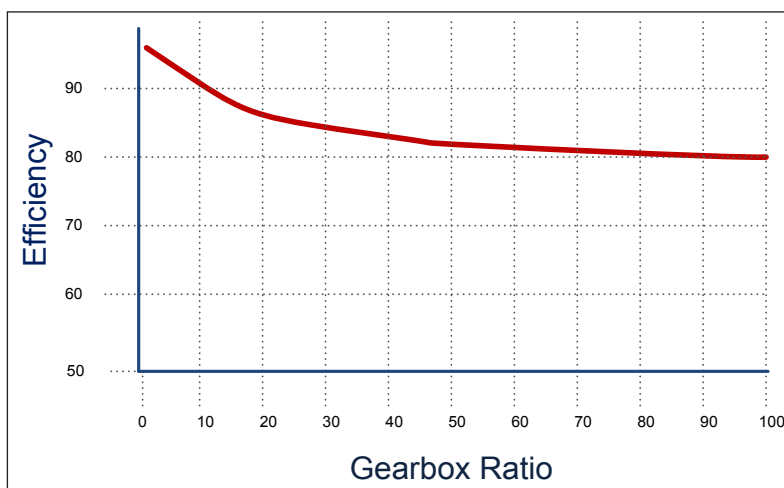


Figure 5 Typical planetary gearbox efficiency.

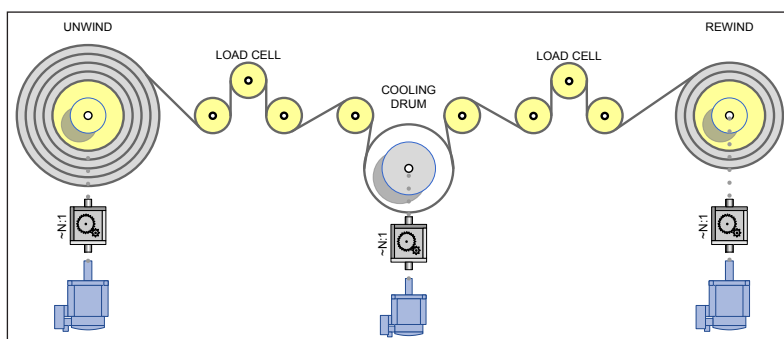


Figure 6 Example machine configuration.

#### Example Machine Specifications

WEB TENSION		
Min.	1.00	Pli
Max.	10.00	Pli

MATERIAL / SPINDLE		
Core	6.75	in.
Full	20.00	in.

LINE SPEED		
Min.	0.25	Fpm
Max	3.00	Fpm
Jog	12.00	Fpm

COOLING ROLL		
Dia.	42.0	in.
Weight	2000.0	lb.

WEB WIDTH		
Min.	6.00	in.
Max.	14.00	in.

maximum torque at full roll (lbf-in) = (full roll diameter [in]/2) \* maximum web tension (lb)/(gear ratio \* gearing efficiency)

maximum speed at core (rpm) = maximum web speed (fpm)/(( $\pi$  \* core diameter [in])/12) \* gear ratio

**Gearbox efficiency.** The gearbox selection will determine the efficiency factor component of the torque calculations. Gearbox efficiency is simply the ratio of the output power (power transmitted through the gearbox as usable work) to the input power. As no mechanical device is 100% efficient, this numeric value of efficiency will always be less than one. If a speed reducer were 100%—efficient, all torque being applied to the input shaft would be applied to the output shaft.

gearbox efficiency = (actual output torque / theoretical output torque) \* 100

Typical gearing options are planetary, helical, worm and pulley/timing belt. Generally, planetary gearboxes are limited to 100:1 ratio, with about a maximum ratio of about ~ 8:1 per stage (although there are exceptions to this rule). Efficiencies for planetary gearing can be considered at ~ 90–95% per stage.

For gear ratios over 100:1 the options are typically multistage worm, helical or combination gearboxes (Figs. 4 and 5).

**Reference machine example.** Consider a machine with: three driven sections; an unwind; a cooling drum as the master and web transport; and a winder. The cooling drum is the system master and is responsible for transporting the web. The unwind and wind spindles are tension-controlled with tension feedback from load cell transducers. The web material being transported is a stainless steel foil. Since the web is non-extendable the mode of tension control for the spindles will be configured as direct torque control.

Power requirements or web hp from the above specifications would be analyzed in the following manner:

$$\text{max web hp} = (10 \text{ pli} * 14 \text{ in}) * 12.00 \text{ fpm} / 33,000 = 0.1508 \text{ hp}$$

Considering the very low power requirements of this system, and that industry tends to use synchronous servo motors in the drive systems when pow-

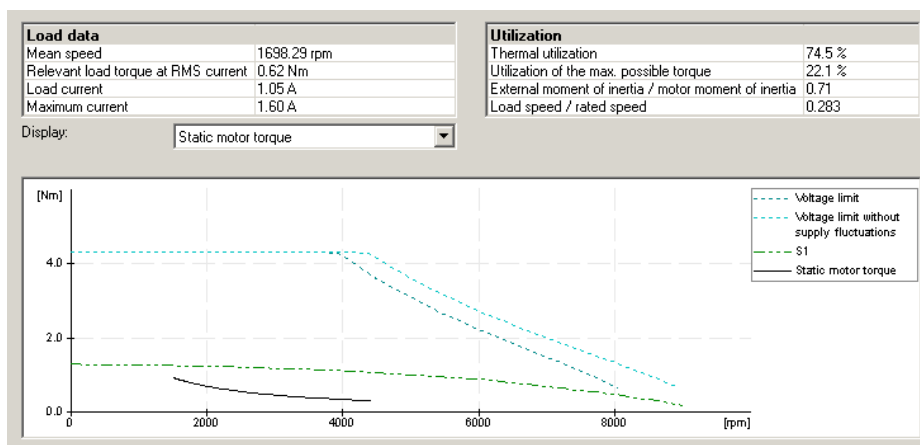


Figure 7 Motor selection/load requirements.

er requirements are at fractional hp and below, we will consider synchronous servo motors for each axis. This type of motor/drive system is common industry practice. Servo motors in this size range will typically have a rated or maximum speed of 4,500 rpm to 6,000 rpm.

Instead of considering power as the sizing criteria, the following sizing examples will select motors based on the criteria of maximum torque requirements at the full roll maximum tension and the maximum speed requirement at maximum speed at core. Since the master (cooling drum) will be speed-regulated, as well as the system lead section, the following exercises concentrate only on the unwind and rewind spindles.

## System Design: Unwind/Rewind

### Step 1. Determine the spindle gear ratios (for a power optimized system).

From the max rpm at the load and the motor base speed, we can determine an optimum gear ratio for a power-optimized system as:

$$\text{maximum rpm@core} = \text{maximum fpm} / ((\pi * [\text{Core Dia.} "/12]) = 12.00 / ((\pi * [6.75"/12]) = 6.79 \text{ rpm}$$

Considering a 4,500 rpm motor, we find an optimized gear ratio as:

$$4,500 \text{ rpm} / 6.79 \text{ rpm} = 662.73:1.$$

For this example we will consider a gearbox ratio of 650:1; this ratio will set the speed at the motor:

$$\text{maximum motor speed at core (rpm)} = \text{maximum web speed} / ((\pi * \text{core diameter} "/12) * \text{gear ratio fpm/}$$

$$((\pi * 6.75"/12) * 650.00 = 4,413.90 \text{ rpm}$$

$$\text{minimum motor speed at full roll (rpm)} = \text{maximum web speed} / ((\pi * \text{core diameter} "/12) * \text{gear ratio} = 0.100 \text{ fpm} / ((\pi * 20"/12) * 650.00 = 31.04 \text{ rpm}$$

Choices for gearboxes in the range of 650:1 are limited and require selection of a multi-stage gearbox to achieve a ratio of that magnitude. We can consider that the typical efficiency of a multi-stage gearbox with a ratio of 650:1 will be in the area of ~ 33 percent.

### Step 2. Determine the spindle torque requirements.

$$\text{maximum torque at core (lbf-in)} = (\text{core diameter}/2) * (\text{maximum web tension}/(\text{gear ratio} * \text{gear efficiency}); (6.75"/2) * (140 \text{ lb}/(650 * 0.33)) = 2.20 \text{ lbf-in}$$

(Note: a system with 90% efficiency would require .807 lbf-in at core)

$$\text{Max torque at full roll (lbf-in)} = ((\text{full roll diameter}/2) * (\text{maximum web tension}/(\text{gear ratio} * \text{gear efficiency})); ((20"/2) * (140 \text{ lb}/(650 * 0.33))) = 6.53 \text{ lbf-in}$$

(Note: a system with 90% efficiency would require 2.39 lbf-in.)

With these load criteria we can consider a synchronous motor with the minimum of 2.20 lbf-in of torque at the maximum speed at core and 6.53 lbf-in of torque at minimum speed @ full roll. Based on the data, we select a standard motor rated for (1.3 Nm) 11.5 lbf-in at 6,000 rpm (Fig. 7).

## Issues with High-Ratio Gearing

**Isolation: friction losses.** The gearbox-related friction losses in efficiency, in effect, isolate the motor from the load. We can see the result of that in how the losses in the high-ratio, multi-stage gearbox have increased the mo-



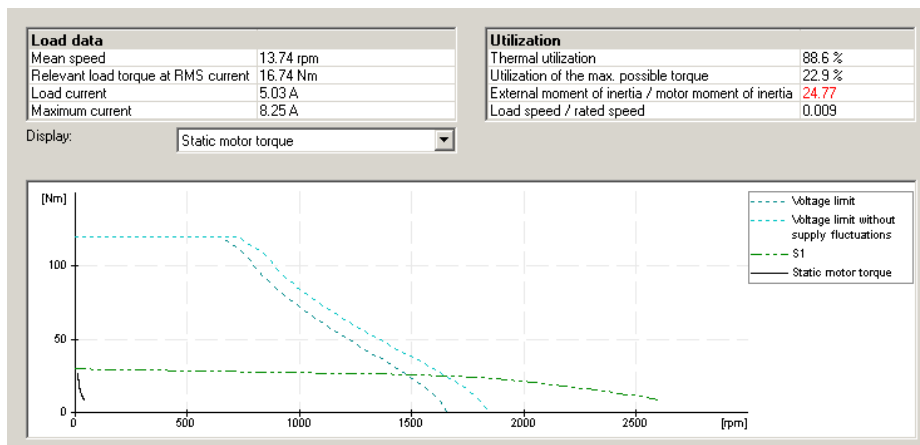


Figure 8 Motor selection/load requirements.

tor torque requirements. It has in fact tripled both the motor and drive size from ~ 2.15 lbf-in to 6.53 lbf-in.

**Active torque control component to friction losses.** The ratio of the active torque control component to the friction losses should be considered in the design process. Consider that in closed-loop tension control modes only a small component of the tension control signal is active, or supplied, by the tension controller. The majority of the tension set-point is provided from the set-point modified by the actual diameter. Normally we can consider the active portion of the tension component signal at about 5% of the tension torque component. Because the friction losses are not static and will, with time, at a constant speed, also vary with speed and load, the tension control system has to work through the dynamic peaks and valleys of the losses.

The torque required to produce maximum tension without considering losses is 2.15 lbf-in. This computes to an active tension control component of  $0.05 * \text{max tension control requirement} = 0.05 * 2.15 \text{ in lb} = 0.1075 \text{ lbf-in}$ .

With friction losses of (6.53 lbf-in - 2.15 lbf-in = 4.38 lbf-in), we find that the output related to the losses is over 40 times the magnitude of the active tension control component output.  $(4.38 \text{ lbf-in} / 0.1075 \text{ lbf-in}) = 40.74$

For effective tension control in the direct-torque-control mode, the active tension control torque signal should be at least equal or greater to the torque required to overcome the gearbox losses.

**Torque ripple-induced tension error.** Another concern for effective tension control in the torque-regulated modes is the tension error that can be caused from the motor's inherent torque ripple when factored through the gearbox ratio. Synchronous servo motors can have a typical torque ripple from ~ 2.5% to < 1% of M0, or the rated motor torque. In this example the motor selected has a rated torque of 11.5 lbf-in. Considering a torque ripple of 2.5%, the ripple at the motor shaft will be  $\sim .025 * 11.5 \text{ lbf-in} = .2875 \text{ lbf-in}$ .

This relates to  $650/1 * .02875 \text{ lbf-in} = 186.875 \text{ lbf-in}$  on the output of the gearbox and  $186.875 \text{ lbf-in} / 10 \text{ in. (full roll radius)} = 18.687 \text{ lb}$  of open-loop tension disturbance on the web at full roll.

Consider also how an oversized motor will add to the open-loop tension error induced by the motor. Additionally, external web tension disturbances will manifest through the system in the same manner.

**Back-driven efficiency.** High ratio gearing can have a much worse efficiency from the load side in comparison to the input that in effect isolates load changes from output shaft significantly.

**Backlash and compliance.** Any lost motion between motor and load, be it backlash or compliance, will have negative effects on the control of the load. Compliance can cause mechanical resonance that reduces servo response and renders the system unstable and difficult to tune. Torsional compliance acts as a spring and also causes resonances. The larger the shaft diameter the stiffer or lower compliance it will have. The more mechanical sections, meaning couplings, gearbox stages, etc. in the system, the more compliance and backlash present.

**Dynamic performance.** There are always disturbances in a system; they can come from torque ripple, out-of-round rolls, tuning, etc. It is possible for a system that is geared to match the lowest web speed to not have enough dynamic response to compensate for the natural disturbance.

**Excess output torque from motor over-sizing.** As ratios increase, any additional torque in the selected motor size from optimal can raise the issue of too much output torque at the output of the gearbox. The outcome can be machine damage with web jams or web breaks. (In this example the motor torque requirement was 6.53 lbf-in and the selected motor was 10.5 lbf-in).

## An Alternative Solution

Utilizing the lowest possible gearbox ratios, or, if practical, direct-driven motors can help eliminate the issues of load isolation through friction losses, reduce the losses to active tension control component, and reduce torque magnification.

Recommendations for gearing, when required, would be to consider an inline single-stage planetary gearbox or timing belt. When considering a timing belt the limiting factor will be the distance between pulley centers.

Table 1 Encoder resolution: minimum speed regulation		
Encoder Type	Minimum speed (Synchronous Motor)	
Resolver (16 Bit)	20.000	RPM
1024 Pulse HTL (Square Wave)	10.000	RPM
2048 Pulse HTL (Square Wave)	5.000	RPM
4096 Pulse HTL (Square Wave)	2.500	RPM
2048 Pulse Sin/Cos Encoder (22 bit)	0.250	RPM
8192 Pulse Sin/Cos Encoder (24 bit)	0.125	RPM

In most cases ratios in the range of 4:1 or less will be the maximum for timing belt gearing arrangements.

High-resolution motor feedback encoders are the key to improving the low-speed regulation of drive systems. With the introduction of the sin/cos optical encoders feedback resolution has been increased from thousands of counts-per-motor-revolution to ~ 4 million-counts-per-revolution for a 22-bit encoder to 16 million-counts-per-revolution for 24 bit encoders. The higher the resolution of the motor feedback sensor, the lower the speed that the drive system can effectively regulate. Table 1 offers a rule of thumb for different encoder technologies and minimum regulated speed.

Considering the same reference specifications on a drive system with a low-ratio, single- stage gearbox with a ratio of 6:1, we determine the following results:

**maximum speed at core**

$$\text{(rpm)} = \text{maximum web speed} / ((\Pi * \text{core diameter}) / 12) * \text{gear ratio } 12.00 \text{ fpm} / ((\Pi * 6.75) / 12) * 6.00 = 40.74 \text{ rpm}$$

**maximum speed at full roll**

$$\text{(rpm)} = \text{maximum web speed} / ((\Pi * \text{full roll diameter}) / 12) * \text{gear ratio } 12.00 \text{ fpm} / ((\Pi * 20) / 12) * 6.00 = 13.75 \text{ rpm}$$

**minimum speed at full roll**

$$\text{(rpm)} = \text{minimum web speed} / ((\Pi * \text{full roll diameter}) / 12) * \text{gear ratio } 0.10 \text{ fpm} / ((\Pi * 20) / 12) * 6.00 = .29 \text{ rpm}$$

$$\text{maximum torque at core (lbf-in)} = ((\text{core diameter} / 2) * (\text{maximum web tension} / (\text{gear ratio} * \text{gear efficiency}))) ((6.75) / 2) * (140 \text{ lb} / (6 * 0.96)) = 82.03 \text{ lbf-in}$$

$$\text{maximum torque at full roll (lbf-in)} = ((\text{full roll diameter} / 2) * (\text{maximum web tension} / (\text{gear ratio} * \text{gear efficiency}))) ((20) / 2) * (140 \text{ lb} / (100 * 0.79)) = 243.06 \text{ lbf-in}$$

With these load criteria we can consider a synchronous motor with the minimum of 82.03 lbf-in of torque at the maximum speed at core (40.74 rpm)

and 243.06 lbf-in of torque at minimum speed @ full roll (0.29 rpm).

Based on the data, we select a standard motor rated for (28 Nm) 247.82 lbf-in of stall torque and (22.5 Nm) 199.15 lbf-in at 2,000 rpm (Fig. 8).

The torque required to produce maximum tension without considering losses is 233.33 lbf-in, giving an active tension control component of  $0.05 * \text{maximum tension requirement} = .05 * 233.33 \text{ in lb} = 11.67 \text{ lbf-in}$ .

With friction losses of (243.06 lbf-in – 233.33 lbf-in = 9.73 lbf-in), we find that the losses in this example are less than the magnitude of the active tension control component.

A motor is selected with a rated speed torque of (28 Nm) 247.82 lbf-in. Considering a torque ripple of 2.5% we find the ripple at the motor shaft to be  $\sim .025 * 247.82 \text{ lbf-in} = 6.19 \text{ lbf-in}$ .

This relates to  $6/1 * 6.19 \text{ lbf-in} = 37.17 \text{ lbf-in}$  on the output of the gearbox, and  $37.17/10 \text{ in (full roll radius)} = 3.72 \text{ lb. of open-loop tension disturbance on the web at full roll}$ .

Selecting low-ratio gearing with increased motor size offers a drive system with a higher level of inherent accuracy and control dynamics. We have gone from a system that had a loss to active tension control component ratio of > 40:1, to a system with a ratio of less than one. And, a system that inherently imparted disturbances of 18.687 lb. of open-loop tension disturbance on the web at full roll to a system that offers 372 lb. of open-loop tension disturbance on the web, five times less open loop tension disturbance.

## Conclusions

Considering the lowest practical gear ratio or, if practical, direct-driven motors for web handling at very low-web-speeds, can enhance machine tension control performance significantly. This is accomplished by eliminating the issues of load isolation through friction losses, reducing the losses to active tension control component ratio, and reducing the torque ripple magnification.

In systems with lower-to-moderate power requirements, the increased cost of the larger drive system in most cases will be offset by the reduced costs of the system gearing.

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**William Gilbert** is a consulting application engineer with the Motion Control Business of Siemens Industry, Inc. He is responsible for the company's converting industry focus and business development for the U.S. market. Gilbert has over 25 years of experience in motion control and web handling-related industries.





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## THE QUESTION

How can I calculate the diameter of the inner race in bearings?

The inner race diameter for a rolling element bearing is a design parameter, and it is chosen by the bearing producer based on various criteria such as rolling element distance, number and diameter of rolling elements, and what interference fit is supposed to be used for a given bearing type. Different (manufacturers) have different ways and targets when optimizing bearing performance, and hence there is no common way to calculate the diameter the inner race for a given, existing bearing.

Without knowing the need for the inner race diameter, a potential use of that measure is to calculate the frequencies related to the different contacts between rolling elements and raceways, as well as the rotational frequency of the cage with rolling element set. These basic frequencies are typically used when analyzing vibration measurements of machines as a way to trace bearings that become damaged. Since the calculation of these basic frequencies requires the actual pitch and rolling element diameters—as well as the actual contact angle for a given bearing—the internet homepages of the larger bearing producers usually provide help. One example is the SKF bearing frequencies calculator, available online or as freeware via iTunes.

The frequencies delivered by such “bearing frequency calculators” are based on basic formulae where the bearing-specific pitch and rolling element diameters are used. By tradition, the four frequencies are often called: “BPFO” (ball pass frequency—outer ring); “BPFI” (ball pass frequency—inner ring); “BSF” (ball spin frequency), referring to the ball. The formulae are, however, valid for roller bearings as well, so the term rolling element diameter is more (precise). The fourth frequency derived from the same data is the “FTF” (fundamental train frequency), which is the rotational frequency for the cage with rolling elements.

With a given and disassembled bearing available, the rolling element and the inner race diameters are, typically, relatively easy to measure; the pitch diameter is then the sum of the inner race diameter and one rolling element diameter. If the bearing has a contact angle, however, this is more difficult to measure—in particular for bearings with curved raceways; e.g.—angular contact ball bearings.

Regards,

**Hans Wendenberg**

**Hans Wendenberg** of SKF Sweden focuses on product development and customer-specific application engineering for a number of industries, particularly those involving custom, high-power-density transmissions. He is currently manager of application development, responsible for the development of performance-related application rules for self-aligning bearings, training and troubleshooting.

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# Effective Management Can Reduce Energy Costs Millwide

By Keith Masters, ABB business manager, pulp and paper systems

## Introduction

It's as true in pulp and paper as it is in many other industries: the continued rise in energy prices has put a squeeze on margin and profits. Paper-makers know that to maintain margin, they must effectively manage their energy costs. But many mills struggle to

use and supply; energy balance management tools to assist in procuring energy at the best available prices; and reporting tools to help monitor energy consumption, costs and efficiency. It's also essential that programs use real-time system data.

Planning tools are essential for predicting energy consumption and calculating a corresponding energy supply schedule. Software can also balance time-varying energy consumption with supply resources.

*Energy Manager* monitors power schedules in real-time so that deviations or unexpected events can be quickly detected

and reported, thus helping to minimize their costs. The energy planning module automatically recalculates the demand schedule based on changes in process measurements, production plans or user inputs. If an imbalance between predicted power consumption

and planned supply is detected, the deviation may be balanced through additional power trading or automated process control.

The *Power (Tie-Line)* monitoring module predicts total utility consumption within the current billing period by integrating and extrapolating the flow in the tie-line. If the predicted volume exceeds pre-set or calculated alarm limits, alarms will alert the operator to take action.

The system generates reports that help users quickly analyze energy and use. Performance reports can detail everything from the consumption and cost of utilities per hour/day/month/year, to benchmarking and analysis of load profile and peak demand.

## Case History Results

**Mayr-Melnh of the Carton Board Group.** In 2001, Mayr-Melnhof Carton Board Group, an international producer of recycled carton board, implemented plant-wide energy management systems at seven of their carton board plants in Austria, Germany, the

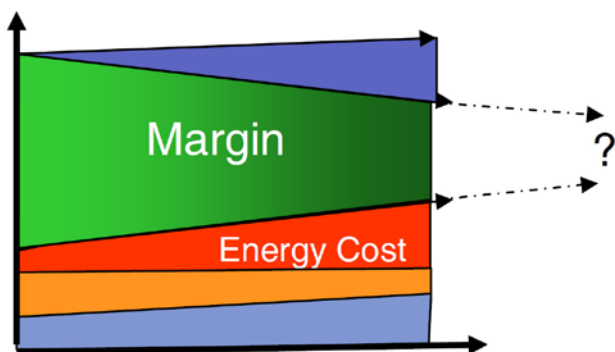


Figure 1 Energy costs impact margin.

find the best ways to reduce what they pay for energy.

Mills can successfully manage energy costs by avoiding price peaks and penalty charges. Other tactics include: using optimal resources to supply electric power; raising plant-wide awareness of energy consumption and its cost; real-time monitoring for early detection of poor performance against set targets; managing electricity purchase prices with accurate consumption plans; and participating in the demand response market.

**Software optimizes energy use.** An energy management system, such as ABB's *Energy Manager*, is a good investment for tracking and cutting plant (mill) energy costs. Plants using *Energy Manager* typically achieve total energy cost reductions of two to five percent. To qualify a program that works for them, mills should look for software that includes both planning and scheduling tools for optimizing energy

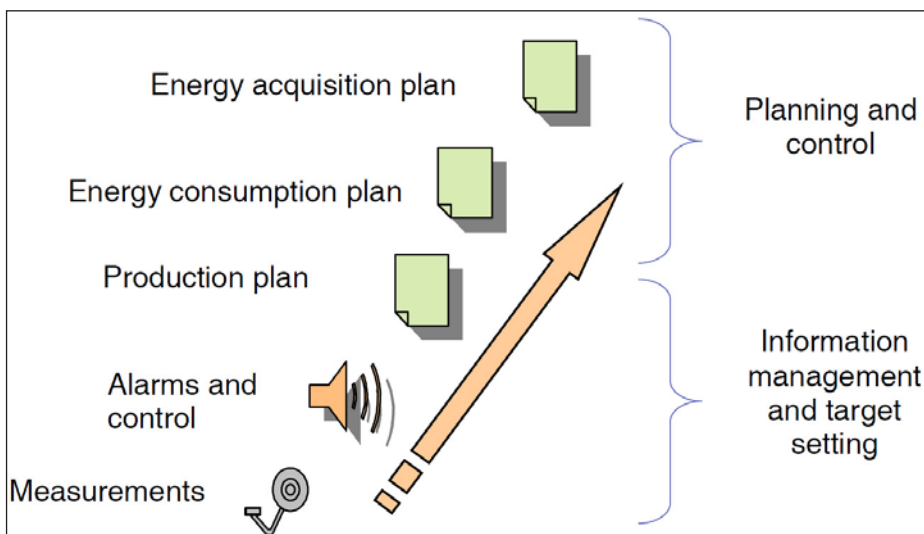


Figure 2 Energy management system functions.



Netherlands, Switzerland and Slovenia.

Every morning, Mayr-Melnhof uses the ABB information system to retrieve data regarding the events of the previous afternoon and evening. "We use the system to manage energy, water, chemicals, compressed air, production and quality data and statistics," explains Johan Maier, who is responsible for energy and water management at Mayr-Melnhof. "The *Energy Management* (software) represents our connection between local processes and offices, and provides a handy instrument for optimizing the process and detecting failures more easily. We are happy with the system and have ordered an upgrade this year in order to obtain further benefits."

**Public Works.** Public Works Government Services Canada (PWGSC) oversees government assets including office buildings and central heating and cooling plants, as well as high-voltage water and sewage distribution systems that vary in size, complexity and age. Its activities include delivering, verifying, planning and reporting on utilities and different grades of fuel for all of these facilities. PWGSC also deals with many different energy suppliers and energy commodities.

PWGSC found that their multiple budgeting, reporting, billing and planning systems could not effectively manage all the required energy and asset management activities. By adding *Energy Manager*, they could optimize energy costs. The system is capable of collecting real-time data from different energy markets. The *Energy Man-*

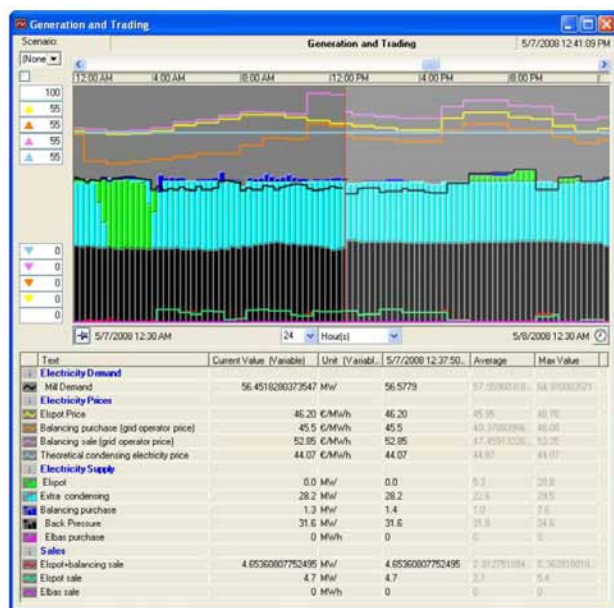


Figure 3 Screen capture example shows how knowing energy demand, prices, supply and sales data can be used to optimize energy resources. This tool is used to balance resources and perform real-time monitoring and predictions.

ager suite supports analysis of the cost impact of different combinations of electricity and natural gas purchased from different sources. This will help PWGSC negotiate and purchase different energy commodities directly from suppliers.

The availability of real-time energy data generated at different building complexes allows PWGSC to perform benchmark analysis of the performance of their properties. PWGSC now uses a wide range of reports including energy usage and cost for each building. All of these activities add up to energy savings at PWGSC.

**Zellstoff Celgar/Castlegar pulp mill, British Columbia.** Canada uses monitoring and reporting features to collect both in-plant energy consumption and the local utility (BC Hydro) data in the real-time format. It is a report-rich system that helps management understand the opportunity cost when they do not sell power to BC Hydro.

The main goals of the ABB system are to improve the stability and reliability of operations; maximize net revenues from power sales; reduce energy costs; and improve overall coordination of power plant and pulp mill operations. **PTE**

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# Considering the Mechanical Aspects of ATEX

By Niilo Nykanen, R+W America

Many engineers and technologists have been aware of electrical ignition sources in hazardous, explosive industrial atmospheres for the last quarter century; this applies to standard design practices both in Europe and North America. During the late 1990s and early 2000s, ATEX 95 Equipment Directive 94/9/EC was implemented in the newly formed European Union to standardize new machine building practices and the maintenance of existing equipment. The ATEX directive is essentially the culmination of best practices utilized in many European nations to avoid accidental ignition of explosive atmospheres during industrial processes. The directive transcends pre-existing national directives and allows for expedited equipment delivery across the EU. ATEX equipment is also becoming

a standard design practice across North America. As global trade increases and NEMA manufactures of explosion-proof equipment cross paths with IEC manufacturers of ATEX products, parallels have been made to cross-reference items made in the EU and North America for certain applications. This often prompts equipment users to revisit older product design standards in order to help balance the requirements. Shaft couplings provide one example.

For the past 30 years or more, designers have paid due diligence to the electrical aspect of hazardous atmosphere equipment design, but have often ignored the mechanical side. In recent years, the mechanical aspects of ATEX design have increasingly come to light. Not only do electrical power transmission products, but also me-



Type: BKL 150 EEx-2003  
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EEx cT4/135°C  
Ser.No.: A 44305  
Tech.Ref.No.:2003/003RW

chanical power transmission products need to comply with the ATEX directive. Many electrical engineers and designers forget that both the electrical and mechanical components of the completed assemblies should not be capable of providing an ignition source in a volatile, combustible atmosphere. If an electrical component such as a motor fails and the windings burn up, or the connections melt down, the standard practice for many years has been to isolate these areas with thick material and gasketing.

More recently this consideration has been applied to mechanical parts that transmit power which may fail. Many North American manufacturers have specified that only non-sparking components in mechanical power transmission couplings may be used, such as aluminum or stainless steel. Although both aluminum and stainless steel can produce sparks in the correct conditions (i.e. a high-speed rotating aluminum part hitting an oxidized steel piece at a glancing angle), they are generally much less prone to produce sparks than carbon steels, especially at high speeds. Another design consideration machine builders need to keep in mind when specifying moving components into potentially hazardous atmospheres is how the parts might strike each other if they fail or are installed incorrectly. A simple example is a glancing blow, much like striking a flint against steel in an antiquated attempt to light a fire. Parts that strike each other in a perpendicular





manner are much less likely to spark in the same manner as a hammer that hits mild steel on an anvil. Eliminating or reducing the potential sparking from mechanical contact or friction (metal to metal or metal to some other type of sparking material) is critical when designing product that may go into an ATEX application. Although this principle is probably a bit newer in the mechanical design world, electrical designers have steered away from anything such as open motor frames and hot surfaces for many years. The bottom line is that any electrical or mechanical device which could be an ignition source for a fire or explosion should not be used in hazardous atmospheres.

When making a coupling selection for a hazardous environment, designers should pay close attention to the possible failure modes and use proper risk assessment principles. Whenever possible, in an explosive atmosphere—driving and driven components, couplings, line shafts, etc., should be designed in such a manner that sparking materials cannot deliver glancing blows to each other in a failure mode. At a speed of 4.5 meters-per-second, a 2 kilo-Newton blow can be a very effective ignition source between steel parts. This means that a rotating steel object as small as 100 mm in diameter, moving at 850 or more rpm with a mass



R+W EK-ATEX couplings are backlash-free, and the conductive elastomer element is very easily press fit into position (all photos courtesy of R+W).

of 200 or greater grams, could produce a significant ignition source if it happened to crash and stop very quickly:

$$F(N) = 1/2 * m(kg) * v(m/s)^2 / s(m),$$

$$2 kN = 1/2 * 2 kg * 4.5 m/s^2 / .001 m,$$

$$850 rpm = 100 mm DIA @ 4.5 m/s rim speed.$$

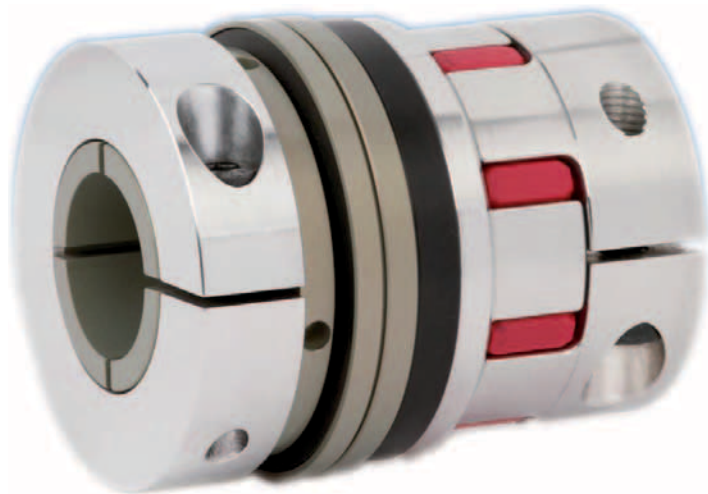
A system designer conducting a failure mode effects analysis (FMEA) must also realize that in some cases a coupling could fail in such a way that the driver and driven hub could lose contact with each other. It is possible that a driven shaft rotating at high speed under its own inertia could produce a static charge. This is due to the fact that most motor and drive line shafts ride in lubricated bearings. Oil and grease do not typically conduct electricity very well. Many electrical transformers are oil filled for this reason. Shafts in electric motors, especially the brush-

less types, tend to build a static charge for various reasons to include asymmetry in the magnetic circuit of rotating electrical machines. These static charges build up as small areas of high potential around the shaft bearings and periodically discharge. This causes micro-

scopic pitting in the bearings and can be a leading cause of bearing failure. Manufacturers often include a grounding brush in ATEX and other NEMA hazardous location motor designs. If a coupling between a driven shaft and motor shaft fails catastrophically and allows the driven shaft to spin freely, arcing could occur in the bearings and air gaps between the remnants of the coupling.

Many mechanical power transmission products already have ATEX certification. As with any other product, just because an industrial power transmission part is certified by an approved body does not necessarily mean that it is the best part for the design of a system. For example, there are many ATEX-certified, flexible disk-style couplings on the market that are widely used in the petrochemical industry. This is due primarily to the disc coupling having been the original type described in the API (American Petroleum Institute) 671 guidelines for special purpose couplings. There are some specific high-speed compressor applications in this industry with a critical reliance upon specific features of the disc pack coupling. These couplings certainly do offer excellent properties for fatigue resistance, high-speed balance, and prevention of static build-up, due to their all-metal construction. This does not mean that this design is free of all negative properties.

SLE Torque Limiter with clamping hubs and elastomer insert.





The EKZ Intermediate Spacer is precision molded and wear resistant.



Machine builders must be aware that when using this style of coupling for ATEX applications, it is possible in the event of a disk, hub and/or, spacer failure, that fasteners and broken pieces of disks could impact each other at various angles. In a worst case scenario a piece of the coupling could flail into a guard or other surrounding metal component(s). If the application is high-speed and/or high-inertia, spark(s) could fly in any direction. Fortunately, the designers of these couplings have put years of consideration into special bolting designs and safety catches for spacers which generally work well in failure mode. This design can become quite complex and costly, oftentimes requiring a customer to assemble many components on site. Since this type of coupling is often mistakenly assumed to be the only option for equipment built in accordance with API guidelines, many system designers use it without considering that alternatives, such as approved elastomer jaw couplings, may be better suited to their

actual requirements.

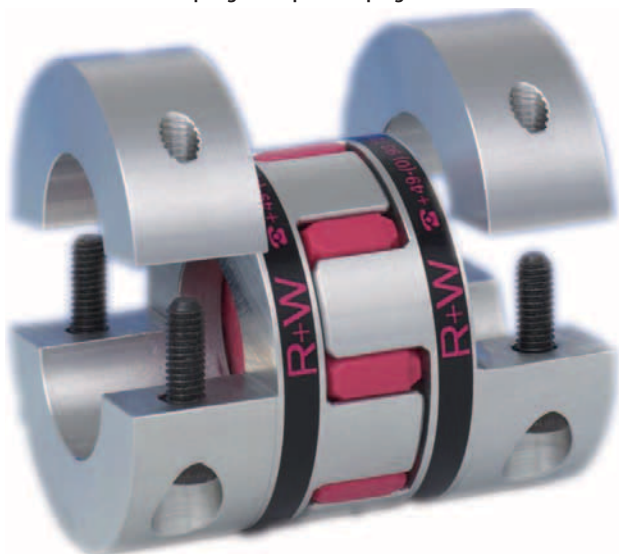
Many ATEX-certified elastomer jaw coupling designs have advanced greatly over the past few decades in terms of their balance, torque density, ease of installation and reliability over long maintenance intervals. Electrically conductive elements are used in order to eliminate the potential for electrostatic charges to arc from one hub to the next. One advantage that an elastomeric jaw-style coupling has over a disk coupling is that in the event the element fails, it might throw a few pieces of rubber or plastic in the surrounding area (versus metal) which typically would not constitute a significant ignition source. In the case of higher quality machined jaw couplings, very seldom does a whole spider element completely disintegrate at once. The jaws are designed with an inward,

opening curvature to positively contain most of the large pieces of the elastomeric element in the event of a failure. If the entire element were lost at once, the jaws would impact each other straight on from a very close distance, much like the dowel bolts in a much more complex disk pack coupling. Once the jaws are impacted the motor can continue to turn the load until an operator or maintenance worker recognizes a problem. A jaw coupling

with a failed elastomeric also maintains electrical continuity between the driver and driven hubs. Guarding design in ATEX applications with an elastomeric jaw coupling can be a bit more simplified as well, compared to other couplings. Because there is no metal disk or element that could potentially be thrown in failure mode, the guard can be more suited to simply protect personnel from coming into contact with rotating parts, rather than creating a re-enforced guard to catch pieces of flying metal.

R+W EK-ATEX couplings are backlash-free, and the conductive elastomer element is very easily press fit into position. Due to a proprietary, secondary molding process, the surfaces of the legs of the elastomer element exhibit a very smooth and straight fit with the precision machined curved jaws, resulting in good electrical conductivity versus many other spider couplings on the market. This smooth even fit also means that there is very consistent compression on the entire elastomer when the machine is running. The result is a less likely chance of failure due to uneven compression compared to elastomeric spiders that are simply pulled from their initial molds and installed. The single elastomeric element not only compensates for a bit of angular shaft misalignment, like a single disk-style coupling, but also for axial and lateral/parallel misalign-

EKH Elastomer Coupling with split clamping hub.



ment. Spacer designs facilitate larger amounts of misalignment and offer easy installation over a wide range of distances between shaft ends, which is also typically useful in API-compliant pump package designs. Split clamping hubs ensure a backlash-free frictional connection, addressing keyway wear and/or eliminating keyways completely, and typically require a fraction of the time for installation and removal.

Catastrophic failures due to unforeseen torque overloads do happen in the field. These failures can be induced from resonant vibrations in the final assembly and can be difficult to predict unless a complex array of electronic sensors is in place throughout the machine. One design advantage of the R+W ATEX coupling is that it is also offered with an optional torque limiting feature, certified and approved for

use in explosive atmospheres. This means that in the event of a mechanical overload, the coupling itself actually disengages rather than causing a catastrophic failure. A mechanical ring on the coupling is designed to move slightly in the event of disengagement. This movement can be used to trigger an electrical signal to alert operators to the problem. In many instances, systems are designed so that disengagement will shut a system down so maintenance personnel can repair the cause of the overload before it causes excess damage to equipment.

In conclusion, when designing a mechanical power transmission system for an ATEX environment, one must be very diligent in the proper selection of parts. Just because a part has a certified marking does not necessarily mean it will always be suitable for

application in each of these areas and environments every time. In order to prevent any electro-static discharge, all moving parts should maintain electrical conductivity between each other. All motor and machine frames must be chassis-grounded, with special attention being paid to any fluid flow processes. Possible failure modes must also be considered to minimize the opportunity for sparks to be generated should the unexpected occur. When choosing ATEX parts it should also be noted to find out from a prospective vendor how long they have been producing hazardous location product, when they were certified, and by what agency. Always choose wisely and get multiple opinions from different vendors and agencies when designing your system. **PTE**

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**Niilo Nykanen** is employed with R+W America L.P. as an application engineer and quality coordinator. He is a specialist in belt, chain, and, close-coupled drives. Nykanen has continuously worked for ATEX certified manufacturing companies since the beginning of 2004. He has been designing and building electro-mechanical parts and systems for his entire career, including product destined for oil processing facilities abroad. Nykanen has various collegiate degrees in manufacturing engineering, electro-mechanical technology, HVAC technology, and is a U.S. Army veteran of four years.



# CRUISING WITH CURIOSITY

## PT Components Help Power NASA's Mobile Laboratory

Matthew Jaster, Associate Editor

Since arriving on Mars on August 5, 2012, the Curiosity rover has been methodically checking things off its lengthy two-year to-do list.

This “Cadillac” of Mars rovers—fully loaded with robotic arms, cameras, laser beams and sensors—is currently examining rocks, scooping soil, taking photographs and trying to determine the habitability of the red planet. While these Mars trips aren’t exactly breaking news at this point (*see Twitter*), it doesn’t change the fact that scientists, engineers, manufacturers and even technology nerds are still very excited about sending a man-made machine to another planet. This isn’t just another been there-done that trip into outer space, we’re talking Mars (fourth planet from the sun, second smallest planet in the solar system, location of many a terrible science fiction film).

In order for Curiosity to function properly, the Jet Propulsion Laboratory (JPL) needed PT components that could withstand the harsh environment found on the planet’s surface. Companies like Forest City Gear, Kaydon Bearing and Maxon Motors responded by creating parts that will

help make the mobile laboratory’s two-year mission a resounding success.

So what was it like being involved in a space exploration project of this magnitude? Being curious ourselves, we made a couple of phone calls.

### Forest City Gear *2x the Pressure to Succeed*

If you’ve ever visited Forest City Gear (FCG), located in Roscoe, Illinois, owner and operator Fred Young may have asked you to touch a gear in the lobby. Not an unusual request given that the gear shop produces a wide variety of products for military, medical, construction and aerospace projects. But it’s not very often that the product in question is heading to another planet.

“I would have people come in and touch the gears and then I’d let them know that their DNA is going to Mars,” Young said. “They were all very excited about the idea.”

How could you not be?

The gears manufactured at FCG have been utilized in home ice cream machines, basketball hoops in gymnasiums and space stations. After supplying gears for the Spirit

and Opportunity Mars rovers, FCG was older, wiser, and more sophisticated. This was vital when the JPL requested 70+ gears for the Curiosity mission.

“They needed gears for different actuator arms, cameras, x-ray equipment, drilling equipment and lasers,” Young said. “JPL was basically turning this vehicle into a mini mobile laboratory to determine the composition of the rocks and the granular structure. Given our experience with the other rovers, I knew our team could handle the request. It was an exciting job.”

And one with its own unique set of challenges.

“JPL wanted 100 percent inspection of every dimension, documentation was necessary and all the gears needed to be serialized,” Young said. “They tested all the actuators, drilling devices and laser beams under all kinds of strange conditions. There was serious pressure to make sure everything worked properly.”

JPL, in fact, sent someone to Roscoe to help with the inspection of the gears since the timetable was so strict. “You basically have a two-week window to launch this thing and if





you miss the deadline, you've got to wait around another two years," Young added.

The magnitude of the project didn't really hit home until Young was watching Curiosity arrive on Mars six months after it had left Earth.

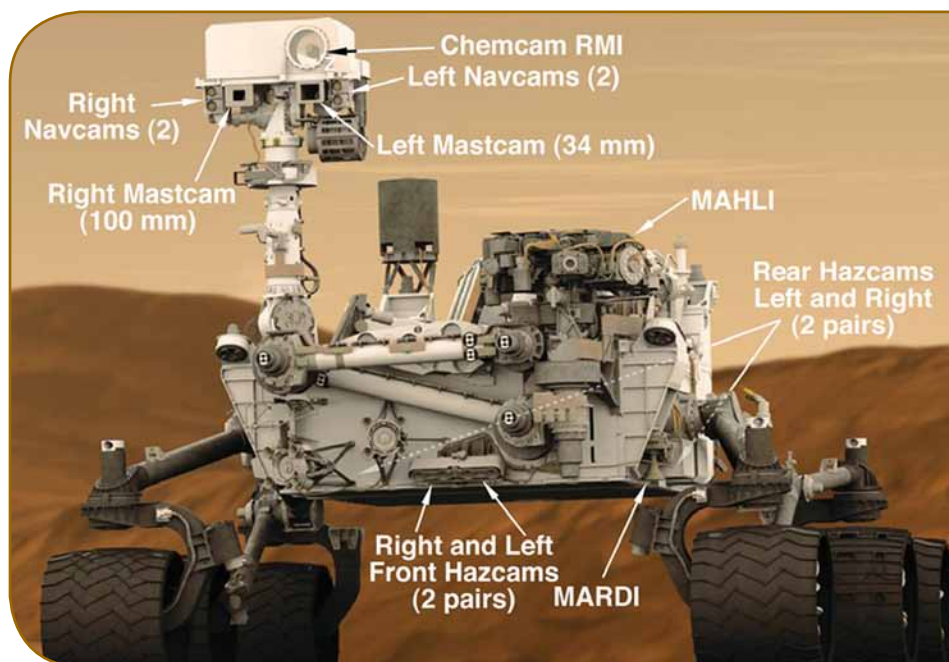
"This thing is going to land on another planet and it damn well better work," he said. To add more pressure, FCG had provided gears for the Sky Crane responsible for lowering the rover to the surface. "We basically had two opportunities to screw up big time if the gears didn't function."

Thankfully, the landing went flawlessly.

While Young jokes that he may be jaded on some of these space projects after participating in more than a few, he's thrilled at the level of excitement found in the FCG staff. Key members like lead gear inspector, Amy Sovina and hobbing set-up technician Kent Blatchford were proud of the work they accomplished. They even shared their stories for a short documentary web series entitled *Our City, Our Story* ([www.ourcityourstory.com](http://www.ourcityourstory.com)).

"It gives our staff confidence because it's such a high visibility project," Young adds, "It's exciting, it's challenging and most importantly it's a great learning experience. To imply that we had a major role in this project is a considerable leap of faith, but bottom line, the gears *had* to work and JPL had to select the best ones to make the trip."

Young credits the work done on Spirit and Opportunity as pivotal to the success of the latest Mars mission. "We were told that Spirit and Opportunity were supposed to last six months when, in fact, they lasted six years. The wealth of information



This graphic shows the locations of the cameras on NASA's Curiosity rover (all photos courtesy of NASA).

they get from each mission is vital for planning the next one."

And is FCG ready if JPL calls on them for another mission to Mars?

"We're ready when they are," Young says. "Hopefully everyone at NASA and JPL remembers who we are and that we did a good job for them."

### **Kaydon Bearings** *Meeting Incredibly High Expectations*

Kaydon Bearings, located in Muskegon, Michigan, can't exactly shy away from extreme bearing applications. They've pretty much become the bread and butter of the company's work in the thin section bearing and slewing ring markets.

"We actively seek out the tough challenges such as space applications because they force us to push the envelope and make us a stronger engineering team," said Scott Hansen, vice president manufacturing planning.

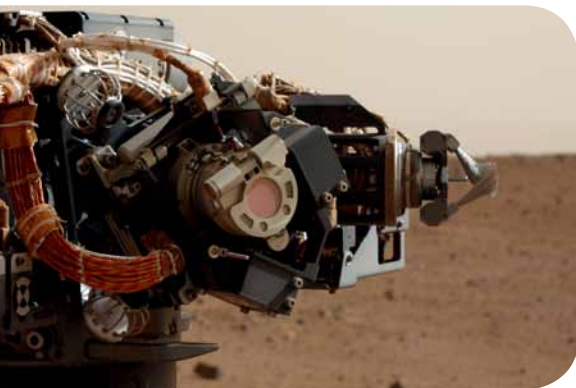
"Kaydon's first space ap-

plication goes back to the 1960s Apollo program. Hamilton Standard had a contract to design a space suit and there were Kaydon Reali-Slim thin section bearings in the joints. The Apollo 15 Lunar rover built by Boeing used Kaydon Reali-Slimes for wheel bearings since tapered roller bearings were too heavy."

Additionally, the company has provided bearings for classified government satellite applications, the Hubble Telescope and the International Space Station, rightfully earning its space credibility. After successful trips to Mars on Spirit, Opportunity and the Phoenix Lander, it was not surprising that Kaydon returned to supply bearings for the Curiosity project.

"Kaydon's Bearing Division was called upon to provide bearings for a variety of parts on Curiosity including the robotic arm, the steering actuators for the rover's wheels and in the deployment mechanism for the remote sensing

mast,” said Robert Roos, senior product engineer. Since the rover boasted the largest, most advanced scientific payload of any Mars mission yet, it required a bearing capable of handling a multitude of harsh environment



The Mars Hand Lens Imager (MAHLI) is one of the tools on a turret at the end of the rover's robotic arm.

tasks—one like the Reali-Slim thin section bearing.

One pair of duplexed Reali-Slim bearings is in the CHIMRA (Collection and Handling for In-Situ Rock Analysis), one of a number of devices mounted on a turret at the end of the rover's robotic arm. These angular contact bearings with a 3-inch O.D. are a key part of the thwack mechanism that must keep the primary sieve from clogging so that samples can reach the analytical instruments. The screens in the sieves have tiny holes—150 micron and 1 mm—to produce particles of the appropriate size; i.e. like a crushed aspirin. JPL engineers decided early on that thin section bearings were the best way to handle the load in the small space available, and built the design around them.

The other four sets of Kaydon bearings (7-inch O.D., 6-inch bore) support the steering actuators on Curiosity's four corners and relieve some of the load on them. This was critical during the landing. These bearings, like those in the CHIMRA, are angular contact with races and balls of 440C stainless steel and a built-in preload. JPL requested that all be shipped dry, including the phenolic separators, so they could add a space-rated lubricant.

Preparing for the Curiosity project was no different than other bearing applications back on Earth, according to Roos. “We start by looking at size and weight constraints. We try to utilize a standard size if at all possible. Then we discuss the various bearing features such as materials, separator or cage type, amount of preload or clearance and lubrication.”

Kaydon then analyzes the loads and speeds to make sure the bearing meets the requirements of the application. “We also take a look at how the bearing fits to the shaft and housing. These can change significantly over the wide temperature range because of differential thermal expansion.”

The most unique feature in the bearings used for Curiosity is the lubricant. “A special dry film lubricant was needed because of the extremely cold environment that the bearings need to operate in,” Roos said.

Kaydon's engineering team was thrilled when called upon to work on another Mars project.

“I believe the Kaydon team derives a great sense of accomplishment and pride in taking on demanding applications such as space. Really, this is as close to exploration as most of us will ever get and it's really amazing to see the fruits of our work unfold on the surface of another planet,” Hansen said.

“These are fun programs to work on,” Roos agreed. “It is very rewarding to see something you have designed working exactly as you expected it would. In many applications you never hear back from the customer when everything is working fine. It's nice to actually see the results of your work!”

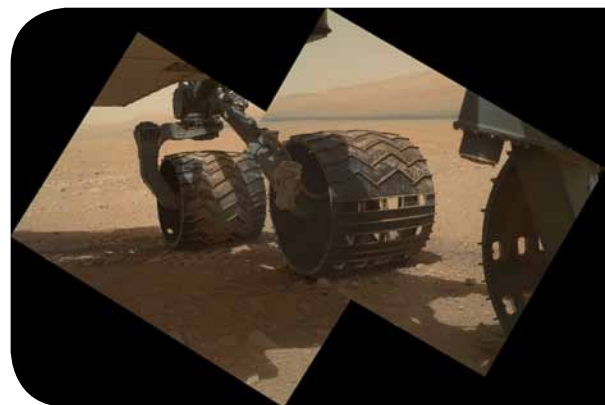
### Maxon Motors *The Need for Advanced Encoder Technology*

While Maxon motors were utilized on Curiosity's little brother, Opportunity, it was Maxon's encoder technology

that was needed for the latest mission to Mars. The company realized some exceptions had to be made to participate in the project. The Swiss-based company normally does not sell, share or license its technology. “It's a closely held secret,” said Robin Phillips, mmAG research and development. “But for a project of this importance, we made an exception.”

“The environmental operating parameters that the JPL needed for the encoders were well outside of the normal range that Maxon works with,” said Jeff Randall, sales engineer. “They had to be functional in very cold and very hot environments. Each part had to be “RAD hardened” or screened under tougher and tougher conditions. Many of the electrical components failed during this process. In the end, the parts that were still functional proved that they can survive the tough operating conditions required of them.”

Mars applications differ from other encoder applications for several key reasons. “They require operation over



The view of the three left wheels combines two images taken by the rover's Mars Hand Lens Imager.

a very wide temperature range (-130 to 130 degrees Celsius) since they have to survive both Martian nights and a sterilization cycle on Earth,” Randall said. “Then there are the vibrations and shock from launch and landing. The biggest difference is that unlike an industrial application, it's not possible to replace a defective part. If something fails in a factory application we can send a replacement, if a motor fails on Mars it causes the loss of a multi-billion dollar mission!”



In contrast to the Opportunity and Spirit rovers, Curiosity can travel further distances on its six wheels and run longer without solar energy as a radio-nuclide battery gives energy for years. The plan is that the rover will explore the immense Gale Crater on Mars for signs of life. This is accomplished with some impressive onboard equipment including a gas chromatograph (to uncover organic compounds) a spectrometer (to analyze rocks) and a two-meter-long robotic arm (to collect the rocks).

The Maxon MR Encoder technology is built into the electro mechanic joints of the rover. The magnetic sensors are mounted on the drive shafts and are responsible for controlling the motors. Apart from that, Maxon's development services for the drive systems have also played a part in the 900 kilogram rover being able to carry out its Mars Mission successfully.

"There are 31 brushless motors on Curiosity that have encoder parts from Maxon," Randall said. "These are used for driving and steering the wheels, moving the science arm joints and moving the camera mast."

Looking back now, both Randall and Phillips reflected on the impact the assignment has had on the entire staff and how it will impact Maxon in the future.

"Maxon likes to take part in these well-known projects. It gives people that work at the factory some pride. There are rover models and displays everywhere at our headquarters in Switzerland. It's nice for the employees to see that their work helps the company support projects like Curiosity," Randall said.

"Applications like this require the latest technology in order to achieve the highest possible power density—meaning the maximum possible power out of the smallest volume and the lightest weight," Phillips said. "This is only possible by working closely with other high-tech suppliers so that we have the newest component designs and use the best production tooling for assembly."

## Science and Progress

So what is Curiosity up to lately? The Mars rover has recently been digging up samples using its full array of analytical instruments to investigate a drift of sandy soil. While initial buzz had scientists down on Earth extremely excited, the rover has not detected any definitive evidence of Martian organics, according to a NASA press release. With Curiosity only four months in to its two-year mission, there's still plenty of time for breaking news stories.

Overall, NASA says the rover is exceeding expectations with all of its instruments and measurement systems performing well. This is a crowning achievement for Forest City Gear, Kaydon, Maxon and all of the other companies that took part in this historic science experiment.

"You never want to go overboard talking about a project like this. It's hard not to, though, given everything that needs to go right for it to be a success," Young said. "My wife occasionally threatens to send *me* up to Mars, if I don't pull back a little." **PTE**

### For more information:

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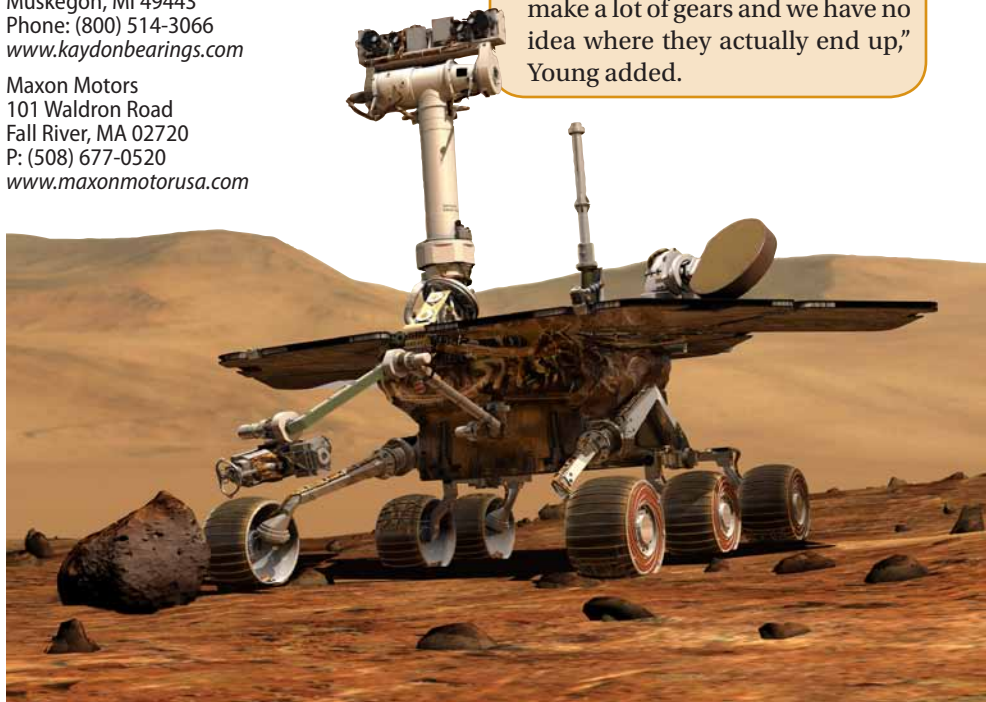
## Not Just Curiosity

It may have taken hundreds of man hours to get certain Curiosity components approved by the JPL and NASA. This doesn't mean that engineers at Kaydon, Maxon and Forest City Gear have been locked in their basements for years focusing on Mars. Curiosity is but one project in a rather impressive list of applications that these companies have worked on.

Maxon, for example, has been developing motors for the commercial space industry. "We've had 10 motors on each of the SpaceX's Dragon spacecraft that has been pioneering commercial space cargo transport to the International Space Station," Phillips said.

Kaydon's Reali-Slim bearings are utilized in the hand pieces of the Intuitive Surgical da Vinci robot to transfer the movement of the surgeon's fingers to the robots arms. "We also redesigned the Honda robot ASIMO which uses nine catalog Reali-Slim bearings in inch and metric sizes," Hansen said.

Forest City provided the gears for the America's Cup racing yacht and has been incredibly busy in medical applications including heart pumps, kidney dialysis machines, x-ray positioning equipment and gears for a portable ventilator system. "We make a lot of gears and we have no idea where they actually end up," Young added.





## About This Directory

The 2012 *Power Transmission Engineering* Buyers Guide was compiled to provide you with a handy resource containing the contact information for significant suppliers of power transmission components.

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Bold Listings throughout the Buyers Guide indicate that a company has an advertisement in this issue of *Power Transmission Engineering*.

## How to Get Listed in the Buyers Guide

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

## Handy Online Resources



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

[www.powertransmission.com/directory/](http://www.powertransmission.com/directory/)



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

[www.geartechology.com/dir/](http://www.geartechology.com/dir/)

## ACCESSORIES

ABL Products Incorporated  
AGI Automation Components  
AISCO Inc.  
ASI Technologies Inc.  
AST Bearings  
Accent Bearings Co. Inc.  
Ace World Companies  
Acorn Industrial Services  
Advanced Antivibration Components - AAC  
Advanced Test & Automation Inc.  
Aerotech Inc.  
Akron Gear and Engineering  
All Metric Small Parts (aMsp)  
Allied-Locke Industries  
Amacoil, Inc.  
American Collars & Couplings, Inc.  
American Plastics Depot  
Ameridrives Power Transmission  
Ametric / American Metric Corporation

### Andantex USA Inc.

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

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Apache Inc.  
Area Distributors Inc.  
Ascent Precision Gear Corporation  
Ashutosh Power TransBelts Limited  
Atlanta Drive Systems Inc.  
Autoparts Solutions Pvt. Ltd.  
Axu s.r.l.  
B&B Manufacturing, Inc.  
BDI - Bearing Distributors Inc.  
BRECOflex CO., L.L.C.  
Baker Bearing Company

### Baldor Electric Company

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

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Bearing Service Company  
Beijing THC Limited  
Belcon Engineers P. Ltd.  
BellowsTech, LLC

### Best Parts Online

17752 COWAN ST  
IRVINE CALIFORNIA 92614  
Phone: (949) 863-3126  
[sales@bestpartsonline.com](mailto:sales@bestpartsonline.com)  
[www.bestpartsonline.com](http://www.bestpartsonline.com)

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### Bevel Gears India Pvt. Ltd.

17B SADARAMANGALA INDUSTRIAL AREA  
WHITEFIELD ROAD  
BANGALORE - 560048, INDIA  
Phone: +(91) 80-28410312  
Fax: +(91) 80-28410185  
[jamalgrp@bevelgearsindia.com](mailto:jamalgrp@bevelgearsindia.com)  
[www.bevelgearsindia.com](http://www.bevelgearsindia.com)

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Bibby Transmissions  
Bishop-Wisecarver Corp.  
Blaney Gears Ltd.  
Bosch Rexroth USA  
Brevini Power Transmission - Canada  
Brewer Machine & Gear Co.  
Brighton Laboratories  
Broach Masters / Universal Gear  
CMS Vibration Solutions Ltd  
Calicut Engineering Works Limited  
Centa Corp.  
Certified Reducer Builders Inc.  
Challenge Power Transmission (Aust) Pty. Ltd.

Challenge Power Transmission PLC  
Chengdu Talent Industrial Co., Ltd.  
Climax Metal Products Company  
Collars and Couplings  
Conroll Corporation  
Core Supply LLC  
Cori Engineers Private Limited  
Cortec Corporation  
Cotta Transmission Company  
Cross + Morse  
Currie Enterprises  
Custom Gear & Machine Inc.  
Custom Machine & Tool Co. Inc.  
Cyclo-Index  
DN Sales Australia  
Daemar Inc.  
Daido Corporation of America  
Dalton Bearing Service, Inc.  
Danaher Motion  
Darbar Belting  
Datasyst Engineering & Testing Services, Inc.  
Daubert Cromwell  
Del-Tron Precision Inc.  
Desch Canada Ltd.  
Donkers Design Solutions  
Drive Systems  
Drive Systems Technology Inc.  
EIC Industry Group  
Econobelt and QTC Gears  
Electro Steel Engineering Company  
Elliot Mfg USA  
Emerson Industrial Automation  
Equipment Concepts

### Excel Gear, Inc.

11865 MAIN STREET  
ROSCOE, IL 61073  
Phone: (815) 623-3414  
Fax: (815) 623-3314  
[chinn@excelgear.com](mailto:chinn@excelgear.com)  
[www.excelgear.com](http://www.excelgear.com)

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Excel Industrial Gears Pvt. Ltd.  
Fey Laminar Rings - North America  
Fife Corporation  
Form Products  
GMB Associates  
GMN Bearing Usa, Ltd.  
GPB Pulleys Makings (Kunshan)  
Gajra Gears Pvt. Ltd.  
Gates Corporation  
Gayatri Gear Industries  
Gear Master Inc.  
Genemax Industrial Inc.  
Global Industrial Products  
Great Northern Products Inc.  
Guardian Industries, Inc.  
H.H. Engineering Works  
HBM  
HEIDENHAIN Corporation  
Hankamp Gears  
Hayes Manufacturing Inc.  
Hi-Grade Inc.  
Houston Pump and Gear  
IBT, Inc  
ISC Companies  
ITW Heartland  
Industrial Indexing Systems  
Industrial Jig & Fixture  
Industrial Pulley & Machine Co, Inc.  
Intech Corporation  
Intellidrives, Inc  
Interinar Electronics  
International Distribution Alliance, Inc.  
JVL Industri Elektronik A/S  
Jason Industrial Inc.  
K+S Services  
KISSsoft, USA, LLC  
KTR Corp.

Kamar Industries  
Kbk Antriebstechnik GmbH  
Kinefac Corporation  
Klubber Lubrication North America L.P.  
LM76 Linear Motion Bearings  
Lange Machinery Group  
Linn Gear  
MAV S.p.A.  
MGT - Magnetic Gearing & Turbine Corp.  
MMB Bearing Co. Inc.  
MROSupply  
MT Tool & Manufacturing  
Magnum Manufacturing  
Magtrol, Inc.  
Maguire Technologies  
Maurey Manufacturing Corporation  
Maxon Precision Motors Inc  
Mayr Corp.  
Mechanical Drives & Belting  
Mechanical Power Inc.  
Ming Chang Traffic Parts Mfg.  
Mini-Broach Machine Company  
Minsk Gear Works

### Motion Industries

1605 ALTON RD.  
BIRMINGHAM, AL 35210  
Phone: (800) 526-9328  
Fax: (205) 957-5290  
[www.motionindustries.com](http://www.motionindustries.com)

Moventas Ltd.  
NAMCO  
NDE Power Transmissions  
NUM Corp. - Schneider Electric  
Netshape Technologies, Inc.  
New England Belting Company  
Nordex Inc.  
North American Clutch Corp. (NORAM)  
Norwin Electronics Limited  
Novotec Argentina SRL  
OEM International Inc.

### Ontario Drive & Gear Ltd.

3551 BLEAMS ROAD  
NEW HAMBURG ONTARIO N3A 2J1, CANADA  
Phone: (519) 662-2840  
Fax: (519) 662-2127  
[info@odg.com](mailto:info@odg.com)  
[www.odg.com](http://www.odg.com)

Onvio LLC  
Optibelt  
Orttech  
Overly Hautz Motor Base Co.  
PI (Physik Instrumente) L.P. Piezo Actuator Nano  
PIC Design  
PUH Sprzet-Kop Rajmund Krakowski  
Paras Lubricants Limited  
Paul's Transmission Shenzhen Co., Ltd  
Peer Bearing Company  
Peerless-Winsmith Inc  
Pioneer Broach Co.  
Pix Europe Limited  
Pix Transmissions Limited  
Plastock - Putnam Precision Molding, Inc.  
Popular Mechanical Works  
Potomac Electric  
Power Transmission Engineers  
Powermach Import & Export Co., Ltd  
Precipart  
Promess Inc.  
Pulley Manufacturers International Inc.  
Purvis Industries

### QA1 Precision Products

21730 HANOVER AVE  
LAKEVILLE, MN 55044  
Phone: 800-721-7761  
Fax: 952-985-5679  
[sales@qa1.net](mailto:sales@qa1.net)  
[www.qa1.net/industrial](http://www.qa1.net/industrial)

Quality Bearings & Components - QBC

### Quality Transmission Components - QTC Gears

125 RAILROAD AVE.  
GARDEN CITY PARK, NY 11040-5016  
Phone: (516) 437-6700  
Fax: (516) 358-9478  
[QTCGearsSupport@qtcgears.com](mailto:QTCGearsSupport@qtcgears.com)  
[www.qtcgears.com/e-store](http://www.qtcgears.com/e-store)

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RGW Sales Canada  
Rathipolybond Pty Ltd.  
Reach Machinery Enterprise  
René Baer AG  
Resistoflex Private Limited

### Rexnord - Process and Motion Control

4701 W. GREENFIELD AVENUE  
MILWAUKEE, WI 53214-5310  
Phone: (414) 643-3000  
Fax: (414) 643-3078  
[www.rexnord.com](http://www.rexnord.com)

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Ritbearing Corp.  
RoMaDyn - Rotating Machinery Engineering Services  
Rockwell Automation  
Romax Technology Limited  
Rowland Co., The  
Rubena A.S.  
SDP/SI  
Sterling Instrument

### Stock Drive Products

2101 JERICHO TURNPIKE  
NEW HYDE PARK, NY 11040  
Phone: (516) 328-3300  
Fax: (516) 326-8827  
[sdp-sisupport@sdp-si.com](mailto:sdp-sisupport@sdp-si.com)  
[www.sdp-si.com](http://www.sdp-si.com)

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SIPCO-MLS  
SIT Indeva, Inc.  
SKG Enterprises  
SPN Schwaben Praezision  
SSJ Italy  
Schenck Trebel Corporation  
Schneeberger Inc.  
Servometer  
Shanthi Gears  
Shree Ganesh Bearings  
Silvertch Industrial (H.K.) Ltd.

### Smalley Steel Ring Company

555 OAKWOOD ROAD  
LAKE ZURICH, IL 60047  
Phone: 847-719-5900  
Fax: 847-719-5999  
[info@smalley.com](mailto:info@smalley.com)  
[www.smalley.com](http://www.smalley.com)

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Smart Manufacturing Technology - SMT  
Specialty Motions, Inc.  
Sprockets Australia Pty. Ltd.  
Stafford Manufacturing Corp.  
Stearns Division / Rexnord Industries Inc.  
Steelmans Broaches Pvt Ltd  
Steinmeyer Inc.  
Sterling Instrument

### Stock Drive Products

2101 JERICHO TURNPIKE  
NEW HYDE PARK, NY 11040  
Phone: (516) 328-3300  
Fax: (516) 326-8827  
[sdp-sisupport@sdp-si.com](mailto:sdp-sisupport@sdp-si.com)  
[www.sdp-si.com](http://www.sdp-si.com)

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Sumitomo Machinery Corp. of America  
T.E.A. Machine Components  
THB Bearings Co. Ltd.  
TSS Rotterdam B.V.  
Taiwan Precision Gear Corp.  
Tapeswitch Corporation  
Team Industries  
Technico  
Techno-Isel

Tef - Cap Industries  
Terog Manufacturing / Black Ace Parts  
Test Equipment Connection  
Tool Masters India  
Torque Transmission  
Transmotec AB  
Transply Inc.  
Trojon Gear Inc.  
Tsubaki of Canada Limited  
Tsubakimoto Chain Co.  
U.S. Tsubaki Power Transmission, LLC  
V2 Engineering Systems  
VCST LP  
VL Motion Systems Inc.  
Valley Gear & Machine Inc.  
Vision Quality Components, Inc.  
Voith Turbo GmbH & Co. KG  
W.M. Berg  
WD Bearing America  
WMH Transmissions Ltd  
Warner Linear  
Whittet-Higgins Company  
Winzeler Gear  
Wyko - London & Overseas Supplies  
Zerelli Technologies Inc  
Zero-Max

## ACTUATORS

AGI Automation Components  
AKGears, LLC  
Acme Gear Co.  
Acorn Industrial Services  
Aerotech Inc.  
Agro Engineers  
Amacoil, Inc.  
Ametric / American Metric Corporation  
Anaheim Automation, Inc.  
Atlanta Drive Systems Inc.  
Avion Technologies Inc.  
BDI - Bearing Distributors Inc.  
Bearings and Industrial Supply Co., Inc.  
Beaver Aerospace and Defense Inc.  
Befared  
BelleFlex Technologies, LLC  
BellowsTech, LLC

### Bevel Gears India Pvt. Ltd.

17B SADARAMANGALA INDUSTRIAL AREA  
WHITEFIELD ROAD  
BANGALORE - 560048, INDIA  
Phone: +(91) 80-28410312  
Fax: +(91) 80-28410185  
[jamalgrp@bevelgearsindia.com](mailto:jamalgrp@bevelgearsindia.com)  
[www.bevelgearsindia.com](http://www.bevelgearsindia.com)

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Bharat Gears Ltd.  
Bishop-Wisecarver Corp.  
Bison Gear and Engineering Corp.  
Bosch Rexroth USA  
Buehler Motor Inc.  
Calicut Engineering Works Limited  
Central Gear & Machine  
Certified Reducer Rebuilders Inc.  
Control Switches International Inc.  
Core Supply LLC  
Curtis Machine Co. Inc.  
DN Sales Australia  
Dalton Bearing Service, Inc.  
Danaher Motion  
Del-Tron Precision Inc.  
Discovery Technology International, Inc.  
Drive Lines Technologies Ltd.  
Drive Systems  
Duff-Norton

# Dunkermotoren USA Inc.

2511 TECHNOLOGY DRIVE, SUITE 105  
ELGIN, IL 60124  
Phone: (224) 293-1300  
Fax: (224) 293-1301  
john.morehead@dunkermotoren.com  
www.dunkermotor.com

Dynamic Structures and Materials, LLC  
Elmrad Engineering Co. Pvt. Ltd.  
Exlar Corporation  
FMC Engineering  
Festo Corporation  
Fife Corporation  
Gear Technology  
Gil Equipamentos Industriais Ltda.  
Hallmark Industries Inc.  
Harmonic Drive LLC  
Heco Gear  
Houston Pump and Gear  
IAI America, Inc.  
IBT, Inc  
ISC Companies  
ITW Heartland  
Industrial Clutch Parts Ltd.  
Intellidrives, Inc  
K+S Services  
LYC North America Inc  
Lab Threads & Gear Works, Inc.  
MROSupply  
Mavilor Motors, S.a.  
Mechanical Drives & Belting  
Micro Ingranaggi Standard sas  
Midwest Motion Products

# Motion Industries

1605 ALTON RD.  
BIRMINGHAM, AL 35210  
Phone: (800) 526-9328  
Fax: (205) 957-5290  
www.motionindustries.com

NAC Harmonic Drive  
Nanjing Cyd Precision Mach. Manu. & Sales Cent  
Ngt Specialty Valves  
Niebuhr Gears  
Nordex Inc.  
North American Clutch Corp. (NORAM)  
Norwin Electronics Limited  
Novotec Argentina SRL  
PI (Physik Instrumente) L.P. Piezo Actuator Nano  
Parker Hannifin Electromechanical Automation Divis  
Performance Gear Systems, Inc.  
Popular Mechanical Works  
Portescap  
Potomac Electric  
Precipart  
Precision Screw Thread  
Promess Inc.  
Purvis Industries  
RGW Sales Canada  
Reach Machinery Enterprise  
Rex Engineering Corp.

# Rexnord - Process and Motion Control

4701 W. GREENFIELD AVENUE  
MILWAUKEE, WI 53214-5310  
Phone: (414) 643-3000  
Fax: (414) 643-3078  
www.rexnord.com

Rockwell Automation  
Rowland Co., The  
S.M. Shah & Company  
SIPCO-MLS  
SPN Schwaben Praezision  
Sallex Machine Tools  
Schneeberger Inc.  
Serapid Inc.  
Servomech US  
Servometer  
Shanthi Gears

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SmartMotor AS  
Specialty Motions, Inc.  
Spinea  
Steinmeyer Inc.  
Sterling Instrument

# Stock Drive Products

2101 JERICHO TURNPIKE  
NEW HYDE PARK, NY 11040  
Phone: (516) 328-3300  
Fax: (516) 326-8827  
sdp-sisupport@sdp-si.com  
www.sdp-si.com

T.E.A. Machine Components  
THB Bearings Co. Ltd.  
TSS Rotterdam B.V.  
Taiwan Precision Gear Corp.  
Tapeswitch Corporation  
Technico  
Techno-Isel  
TelcoMotion  
The Precision Alliance  
Tolomatic, Inc.  
Transmotec AB  
Tsubakimoto Chain Co.  
U.S. Tsubaki Power Transmission, LLC  
Ultra Motion  
VL Motion Systems Inc.  
Vision Quality Components, Inc  
Warner Linear  
Wittenstein (formerly alpha gear drives)  
Wyko - London & Overseas Supplies  
Yaskawa America, Inc. - Drives & Motion Divisi  
Zero-Max

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P3

# ADJUSTABLE SPEED DRIVES

A. Fischer Phase Drives  
AISCO Inc.  
AKGears, LLC  
ASI Technologies Inc.  
Ace World Companies  
Acme Gear Co.  
Aerotech Inc.  
Agro Engineers  
Allied Motion  
Amacoil, Inc.  
Ametric / American Metric Corporation

# Andantex USA Inc.

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

Area Distributors Inc.  
Atlanta Gear Works, Inc

# Automation Direct

3505 HUTCHINSON ROAD  
CUMMING, GA 30040  
Phone: (800) 633-0405  
Fax: (770) 889-7876  
sales@automationdirect.com  
www.automationdirect.com

B&B Manufacturing, Inc.  
BDI - Bearing Distributors Inc.

# Baldor Electric Company

5711 R.S. BOREHAM, JR. ST.  
P.O. BOX 2400  
FORT SMITH, AR 72901  
Phone: (479) 646-4711  
Fax: (479) 648-5792  
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Bearing Service Company  
Beaver Aerospace and Defense Inc.

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# Bevel Gears India Pvt. Ltd.

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WHITEFIELD ROAD  
BANGALORE - 560048, INDIA  
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Fax: +(91) 80-28410185  
jamalgrp@bevelgearsindia.com  
www.bevelgearsindia.com

Bison Gear and Engineering Corp.  
Bodine Electric Company  
Bonfiglioli Riduttori S.p.A.  
Bonfiglioli USA  
Bosch Rexroth USA  
Boston Gear  
Brevini Power Transmission - Canada  
Brevini USA  
Brewer Machine & Gear Co.  
Buehler Motor Inc.  
Calicut Engineering Works Limited  
Carlisle Power Transmission  
Carlyle Johnson Machine Co. LLC  
Central Gear & Machine  
Certified Reducer Builders Inc.  
Cerus Industrial  
Challenge Power Transmission PLC  
Churon Co.  
Cleveland Gear Co.  
Conroll Corporation  
Cotta Transmission Company  
Custom Motors Inc.  
Cutes Corporation  
D&D Power Transmission Products  
Dalton Bearing Service, Inc.  
Danaher Motion  
Drive Systems  
Duff-Norton

# Dunkermotoren USA Inc.

2511 TECHNOLOGY DRIVE, SUITE 105  
ELGIN, IL 60124  
Phone: (224) 293-1300  
Fax: (224) 293-1301  
john.morehead@dunkermotoren.com  
www.dunkermotor.com

Dynamic International Enterprise Ltd.  
Dynex/Rivett Inc.  
Electronic Machine Parts  
Elmrad Engineering Co. Pvt. Ltd.  
Essential Power Transmission Pvt. Ltd.  
Excel Industrial Gears Pvt. Ltd.  
FMC Engineering  
Fairchild Industrial Products Co.  
Festo Corporation  
GMB Associates  
Gayatri Gear Industries  
Gear Technology  
Gil Equipamentos Industriais Ltda.  
HPB Motion Control Co. Ltd.  
Harmonic Drive LLC  
Hoffmann Technics Ag  
Houston Pump and Gear  
IBT, Inc  
ISC Companies  
Industrial Indexing Systems  
Intellidrives, Inc  
K+S Services  
KB Controls  
Kraft Power Corporation

# Lafert North America

5620 KENNEDY RD.  
MISSISSAUGA ONTARIO L4Z 2A9, CANADA  
Phone: (800) 661-6413  
Fax: (905) 629-2852  
sales@lafertna.com  
www.lafertna.com

Marshall Wolf Automation Inc.  
Master Power Transmission  
Maurey Manufacturing Corporation

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Mavilor Motors, S.a.  
Mechanical Drives & Belting  
Merit Gear Corp.  
Mitsubishi Electric Automation, Inc.

### Motion Industries

1605 ALTON RD.  
BIRMINGHAM, AL 35210  
Phone: (800) 526-9328  
Fax: (205) 957-5290  
[www.motionindustries.com](http://www.motionindustries.com)

NAC Harmonic Drive  
NAMCO  
New Power Electric (USA) LLC  
Nord Gear Corp.  
Nordex Inc.  
Norwin Electronics Limited  
Novotec Argentina SRL

### Ontario Drive & Gear Ltd.

3551 BLEAMS ROAD  
NEW HAMBURG ONTARIO N3A 2J1, CANADA  
Phone: (519) 662-2840  
Fax: (519) 662-2127  
[info@odg.com](mailto:info@odg.com)  
[www.odg.com](http://www.odg.com)

PI (Physik Instrumente) L.P. Piezo Actuator Nano  
Performance Gear Systems, Inc.  
Phytron, Inc.  
Potomac Electric  
Precipart  
Purvis Industries  
René Baer AG

### Rexnord - Falk Division

3001 W. CANAL STREET  
MILWAUKEE, WI 53208  
Phone: 866-739-6673  
Fax: 614-675-1898  
[info@rexnord.com](mailto:info@rexnord.com)  
[www.rexnord.com](http://www.rexnord.com)

Rockwell Automation  
S.M. Shah & Company  
SEW-Eurodrive  
SSJ Italy  
Sallex Machine Tools  
Serapid Inc.  
Shanthi Gears  
Shimpo Drives Inc.  
Siemens Industry, Inc.  
Siti Spa Riduttori  
SmartMotor AS  
Specialty Motions, Inc.  
Sprint Electric Ltd.  
Sprockets Australia Pty. Ltd.  
Sterling Instrument

### Stock Drive Products

2101 JERICHO TURNPIKE  
NEW HYDE PARK, NY 11040  
Phone: (516) 328-3300  
Fax: (516) 326-8827  
[sdp-sisupport@sdp-si.com](mailto:sdp-sisupport@sdp-si.com)  
[www.sdp-si.com](http://www.sdp-si.com)

Sumitomo Machinery Corp. of America  
Suzhou Asia Pacific Metal Co., Ltd.  
TB Wood's  
THB Bearings Co. Ltd.  
TVT America, Inc.  
Taiwan Precision Gear Corp.  
Team Industries  
Techno-Isel  
Teco Westinghouse  
Tolomatic, Inc.  
Tramec s.r.l.  
Transmission Machinery Co. Ltd.  
Transmotec AB  
Transply Inc.  
Tsubakimoto Chain Co.  
U.S. Tsubaki Power Transmission, LLC

VL Motion Systems Inc.  
Valley Gear & Machine Inc.  
Vision International  
Vision Quality Components, Inc.  
Voith Turbo GmbH & Co. KG  
W.M. Berg  
Wyko - London & Overseas Supplies  
Xuzhou Beilai Engineering Machinery Co., Ltd  
Yaskawa America, Inc. - Drives & Motion Divisi  
Zero-Max

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## BEARINGS

AST Bearings  
Abbott Ball Company  
Accent Bearings Co. Inc.  
Acorn Industrial Services  
Aerotech Inc.  
Allied-Locke Industries  
American Plastics Depot  
American Swiss Products Co., Inc.  
Ametric / American Metric Corporation  
Area Distributors Inc.  
B&B Manufacturing, Inc.  
BCC (USA) Inc.  
BDI - Bearing Distributors Inc.  
Baker Bearing Company

### Baldor Electric Company

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

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Barrel Service Company  
Bearing Service Company  
Bearings2000  
Beijing THC Limited  
BelleFlex Technologies, LLC  
Bently Pressurized Bearing Co.  
Bishop-Wisecarver Corp.  
Bison Gear and Engineering Corp.  
Boca Bearing Company  
Bosch Rexroth USA  
Boston Gear  
Brewer Machine & Gear Co.  
CCVI Bearing  
CNN Bearings  
Carlisle Power Transmission  
Central Gear & Machine  
Certified Reducer Rebuilders Inc.  
Challenge Power Transmission (Aust) Pty. Ltd.  
Challenge Power Transmission PLC  
Churon Co.  
Climax Metal Products Company  
Core Supply LLC  
Cori Engineers Private Limited  
Cotta Transmission Company  
Craft Bearing Company, Inc.  
Cross + Morse  
D&D Power Transmission Products  
Daemar Inc.  
Dalton Bearing Service, Inc.  
Danaher Motion  
Del-Tron Precision Inc.  
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Drive Systems  
Dynamic International Enterprise Ltd.  
EIC Industry Group  
Emerson Industrial Automation  
Excel Industrial Gears Pvt. Ltd.  
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FMC Engineering  
FYH Bearing Units USA, Inc.  
Formsprag Clutch

Fusion Babbiting Co, Inc  
GMB Associates  
GMN Bearing Usa, Ltd.  
GPB Pulleys Makings (Kunshan)  
Gil Equipamentos Industriais Ltda.  
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Houston Pump and Gear  
IBT, Inc  
IMO USA Corp.  
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Industrial Friction Materials Ltd.  
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International Distribution Alliance, Inc.  
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Kaydon Corporation Bearings Division  
Kilian Manufacturing Corp.  
Kinefac Corporation  
LM76 Linear Motion Bearings  
LYC North America Inc  
Lange Machinery Group  
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Linn Gear  
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MMB Bearing Co. Inc.  
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Pacific Bearing  
Paul's Transmission Shenzhen Co., Ltd  
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Peerless-Winsmith Inc  
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### QA1 Precision Products

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SSJ Italy  
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Unisoft Pheripherals  
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Vision Quality Components, Inc.  
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WMH Transmissions Ltd  
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Wolee Bearings  
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Xuzhou BeiLai Engineering Machinery Co., Ltd  
Yogi Bearings  
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Ascent Precision Gear Corporation  
Ashutosh Power TransBelts Limited  
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Bosch Rexroth USA  
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Brevini Power Transmission - Canada  
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Calicut Engineering Works Limited  
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Darbar Belting  
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Linn Gear  
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SEW-Eurodrive  
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SSJ Italy  
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Taiwan United Gear Co., Ltd.  
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Tool Masters India  
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Tsubakimoto Chain Co.  
U.S. Gear  
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Vision Quality Components, Inc.  
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Bison Gear and Engineering Corp.  
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Carlyle Johnson Machine Co. LLC  
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Force Control Industries  
GKN Land Systems  
GMB Associates  
Gummi Usa  
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Hoffmann Technics Ag  
IBT, Inc  
ISC Companies  
Industrial Clutch  
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Brewer Machine & Gear Co.  
C-B Gear & Machine

Calicut Engineering Works Limited  
Central Gear & Machine  
Certified Reducer Rebuilders Inc.  
Challenge Power Transmission (Aust) Pty. Ltd.  
Challenge Power Transmission PLC  
Churon Co.  
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Cloyes Gear & Products Inc.  
Commercial Gear & Sprocket Co. Inc.  
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Cross + Morse  
D&D Power Transmission Products  
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Dalton Bearing Service, Inc.  
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Davall Gears Ltd.  
Diamond Chain Company  
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Dynamic International Enterprise Ltd.  
Econobelt and QTC Gears  
Electro Steel Engineering Company  
Emerson Industrial Automation Excel Industrial Gears  
Pvt. Ltd.  
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GMB Associates  
Gates Corporation  
Gayatri Gear Industries  
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MT Tool & Manufacturing  
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Paul's Transmission Shenzhen Co.,Ltd  
Peer Bearing Company  
Performance Gear Systems, Inc.  
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Powermach Import & Export Co.;Ltd  
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Carlyle Johnson Machine Co. LLC  
Centa Corp.

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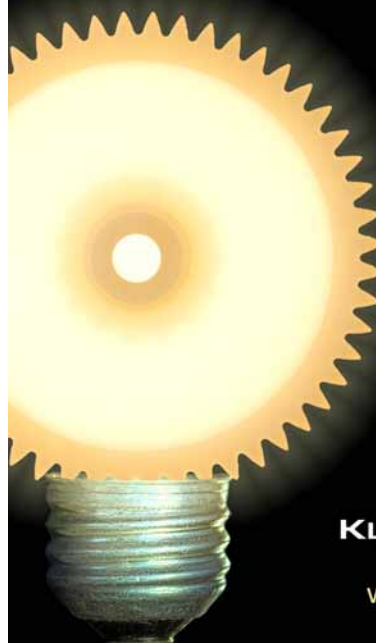
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11715 MAIN STREET  
ROSCOE, IL 61073  
Phone: (815) 623-2168  
Fax: (815) 623-6620  
rmikel@fcgear.com  
www.fcgear.com

GAM Gear  
GKN Driveline  
GMB Associates  
Gayatri Gear Industries  
Gear Technology

### Gear Works - Seattle, The

P.O. BOX 80886  
500 SO. PORTLAND ST.  
SEATTLE, WA 98108  
Phone: (206) 762-3333  
Fax: (206) 762-3704  
jmagnumson@thegearworks.com  
www.thegearworks.com

Gear World SpA  
Genemax Industrial Inc.  
Gerhardt Gear Co. Inc.  
Ghatge Patil Industries  
Goodwill Engineering  
Groschopp Inc.  
H.H. Engineering Works  
HPB Motion Control Co. Ltd.  
Hallmark Industries Inc.  
Harmonic Drive LLC  
Haumea Srl  
Heco Gear  
Hoffmann Technics Ag  
Horsburgh & Scott  
Houston Pump and Gear  
IBT, Inc  
ISC Companies  
ITW Heartland  
Indiana Tool/Indiana Gear  
Industrial Jig & Fixture  
Insko Corp.  
Intecno USA  
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JVL Industri Elektronik A/S  
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JinHang Precision Bearing Co.,Ltd  
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### Lafert North America

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MISSISSAUGA ONTARIO L4Z 2A9, CANADA  
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sales@lafertna.com  
www.lafertna.com

Luoyang Goldeng Slewing Ring Co.,Ltd  
Marswell Engineering Ltd.  
Master Power Transmission  
Maxon Precision Motors Inc  
Mechanical Drives & Belting  
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Merit Gear Corp.  
Micro Ingranaggi Standard sas  
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Midwest Motion Products  
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Milwaukee Gear Co.

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Minsk Gear Works

**Motion Industries**

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BIRMINGHAM, AL 35210  
Phone: (800) 526-9328  
Fax: (205) 957-5290  
[www.motionindustries.com](http://www.motionindustries.com)

Moventas Ltd.

MultiProducts Company Inc.  
NAC Harmonic Drive  
NAMCO  
Nanjing Excellence Industrial Co., Ltd.  
Niebuhr Gears  
Nord Gear Corp.  
Nordex Inc.  
Norwin Electronics Limited  
Nuttall Gear  
Oerlikon Fairfield  
Oerlikon Graziano SpA  
Ondrives Ltd

**Ontario Drive & Gear Ltd.**

3551 BLEAMS ROAD  
NEW HAMBURG ONTARIO N3A 2J1, CANADA  
Phone: (519) 662-2840  
Fax: (519) 662-2127  
[info@odg.com](mailto:info@odg.com)  
[www.odg.com](http://www.odg.com)

Onvio LLC

Ormec  
Overton Chicago Gear Corporation  
P. G. DRIVE  
PIC Design  
Palmer Johnson Power Systems  
Parker Hannifin Electromechanical Automation Divis  
Peerless-Winsmith Inc  
Performance Gear Systems, Inc.  
Phytron, Inc.  
Plastock - Putnam Precision Molding, Inc.  
Popular Mechanical Works  
Portescap  
Power Transmission Engineers  
Precipart  
Precision Microdrives Limited  
Premier Machine & Gear Ltd.  
Punjab Gears  
Purvis Industries  
Quality Reducer Service

**Quality Transmission Components - QTC Gears**

125 RAILROAD AVE.  
GARDEN CITY PARK, NY 11040-5016  
Phone: (516) 437-6700  
Fax: (516) 358-9478  
[QTCGearsSupport@qtcgears.com](mailto:QTCGearsSupport@qtcgears.com)  
[www.qtcgears.com/e-store](http://www.qtcgears.com/e-store)

R. Cushman & Associates Inc.

RJ Link International, Inc.  
Reach Machinery Enterprise  
Redex Andantex  
Renk Test Systems  
Renold Australia Proprietary Ltd.  
Rex Engineering Corp.

**Rexnord - Falk Division**

3001 W. CANAL STREET  
MILWAUKEE, WI 53208  
Phone: 866-739-6673  
Fax: 614-675-1898  
[info@rexnord.com](mailto:info@rexnord.com)  
[www.rexnord.com](http://www.rexnord.com)

**Rexnord - Process and Motion Control**

4701 W. GREENFIELD AVENUE  
MILWAUKEE, WI 53214-5310  
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Fax: (414) 643-3078  
[www.rexnord.com](http://www.rexnord.com)

Riley Gear

Rockwell Automation

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Rowland Co., The

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SEW-Eurodrive  
SIPCO-MLS  
SPN Schwaben Praezision  
SSJ Italy  
Sallex Machine Tools  
Sam Gears India Pvt.Ltd  
Schneeberger Inc.  
Setco Precision Spindles, Slides & Service  
Shanthi Gears  
Shimpo Drives Inc.  
Siemens Industry, Inc.  
Siti Spa Riduttori  
Sokhi Heli-Wom Gears Pvt. Ltd.  
Sond Gears Pvt. Ltd.  
Source Engineering Inc.  
Spinea  
Spline Gauges  
Star Gears  
Sterling Instrument

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**Stock Drive Products**

2101 JERICHO TURNPIKE  
NEW HYDE PARK, NY 11040  
Phone: (516) 328-3300  
Fax: (516) 326-8827  
[sdp-sisupport@sdp-si.com](mailto:sdp-sisupport@sdp-si.com)  
[www.sdp-si.com](http://www.sdp-si.com)

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TSS Rotterdam B.V.  
TVT America, Inc.  
Taiwan Precision Gear Corp.  
Taiwan United Gear Co., Ltd.  
Team Industries  
TelcoMotion  
Toledo Gearmotor A Bluffton Motor Works Company  
Tolomatic, Inc.  
Tool Masters India  
Torque Transmission  
Tramec s.r.l.  
Transmission Machinery Co. Ltd.  
Transmotec AB  
Transply Inc.  
Triumph Gear Systems - ACR Industries  
Trojan Gear Inc.  
Tsubakimoto Chain Co.  
U.S. Gear  
U.S. Tsubaki Power Transmission, LLC  
VL Motion Systems Inc.  
Vision Quality Components, Inc  
Voith Turbo GmbH & Co. KG  
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WMH Transmissions Ltd  
WPT Power Corporation  
Wilson Machine Co. Ltd.  
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Wyko - London & Overseas Supplies  
Xtek, Inc.  
Xuzhou BeiLai Engineering Machinery Co., Ltd  
Yaskawa America, Inc. - Drives & Motion Divisi  
Zero-Max

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Aerocom Industries Inc.

Agro Engineers  
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Allied Gear Co.  
Allied Specialty Precision Inc.  
American Gear & Engineering  
American Gear, Inc.  
American Plastics Depot  
American Swiss Products Co., Inc.  
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Ancon Gear & Instrument Corp.  
Ascent Precision Gear Corporation  
Ashot Ashkelon Industries Ltd.  
Atlanta Gear Works, Inc  
Autoparts Solutions Pvt. Ltd.  
Avion Technologies Inc.

**B & R Machine and Gear Corp.**

4809 U.S. HWY. 45  
SHARON, TN 38255  
Phone: (731) 456-2636 or (800) 238-0651  
Fax: (731) 456-3073  
[inquiry@brgear.com](mailto:inquiry@brgear.com)  
[www.brgear.com](http://www.brgear.com)

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B&B Manufacturing, Inc.

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Bearing Service Company  
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Bowmar LLC  
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Brevini Wind USA  
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Broaching Technologies, LLC  
Broadway Gear  
Buffalo Gear, Inc.  
Butler Gear  
C-B Gear & Machine  
Calicut Engineering Works Limited  
Carnes-Miller Gear Co., Inc.  
Cattini & Figlio s.r.l.  
Central Gear & Machine  
Certified Reducer Builders Inc.  
Cestari Industrial e Comercial S.A.  
Chenta Gear - USA  
Churon Co.  
Cincinnati Gearing Systems

**Circle Gear & Machine Co.**

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CICERO, IL 60804  
Phone: (708) 652-1000  
Fax: (708) 652-1100  
[circlegear@circlegear.com](mailto:circlegear@circlegear.com)  
[www.circlegear.com](http://www.circlegear.com)

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Clark Gear Works, Inc.

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Cloyes Gear & Products Inc.  
Cogmatic, Inc.  
Columbia Gear Corp.  
Commercial Gear & Sprocket Co. Inc.  
Cone Drive Gearing Solutions  
Cotta Transmission Company  
Cross + Morse  
Curtis Machine Co. Inc.  
Custom Machine & Tool Co. Inc.  
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Dalton Bearing Service, Inc.  
Davall Gears Ltd.  
David Brown Gear Systems Ltd.  
Delroyd Worm Gear  
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Delta Gear Company  
Delta Gear Inc.

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ASI Technologies Inc.  
Accent Bearings Co. Inc.  
Accurate Gear and Machine, Inc.  
Ace World Companies  
Acme Gear Co.  
Adams Company

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Drive Systems  
Dynamic International Enterprise Ltd.  
EM Gear / Dae Seong Gear  
Elda Machining Co. Ltd.  
Electronic Machine Parts  
Engranajes Masia, S.L.

**Excel Gear, Inc.**  
11865 MAIN STREET  
ROSCOE, IL 61073  
Phone: (815) 623-3414  
Fax: (815) 623-3314  
chinn@excelgear.com  
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Excel Industrial Gears Pvt. Ltd.  
FMC Engineering  
Federal Gear

**Forest City Gear Co.**  
11715 MAIN STREET  
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Phone: (815) 623-2168  
Fax: (815) 623-6620  
rmikel@fcgear.com  
www.fcgear.com

GKN Driveline  
GMB Associates  
GTA Gear Technology & Applications BV  
Gajra Gears Pvt. Ltd.  
Gayatri Gear Industries  
Gear Design & Service Pty. Ltd.  
Gear Master Inc.

**Gear Motions, Inc.**  
1750 MILTON AVENUE  
SYRACUSE, NY 13209  
Phone: (315) 488-0100  
www.gearmotions.com

Gear Technology

**Gear Works - Seattle, The**  
P.O. BOX 80886  
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Phone: (206) 762-3333  
Fax: (206) 762-3704  
jmagnuson@thegearworks.com  
www.thegearworks.com

Gear World SpA  
GearTec Inc.  
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Gerhardt Gear Co. Inc.  
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Goodwill Engineering  
Great Lakes Industry Inc.  
Griffin Gear Co.  
Guardian Industries, Inc.  
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Hankamp Gears  
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Hayes Manufacturing Inc.  
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Horsburgh & Scott  
Houston Pump and Gear  
IBT, Inc  
ISC Companies  
ITW Heartland  
Industrial Gears Watteeuw  
Industrial Jig & Fixture  
Italgear S.r.l.  
Jahnel - Kestermann GmbH & Co. Kg  
JinHang Precision Bearing Co., Ltd  
Kamar Industries  
Kinefac Corporation

**Kleiss Gears, Inc.**  
390 INDUSTRIAL AVENUE  
GRANTSBURG, WI 54840  
Phone: 715-598-4492  
Fax: 715-463-5996  
drichter@kleissgears.com  
www.kleissgears.com

Link Gear & Machine Company  
MECA & Technology Machine Inc.  
MT Tool & Manufacturing  
Magnum Manufacturing  
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Mechanical Drives & Belting  
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Mijno Precision Gearing  
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Mini-Broach Machine Company  
Minsk Gear Works  
Moore Gear & Mfg. Co., Inc.  
Moventas Ltd.  
NAMCO  
Nanjing Excellence Industrial Co., Ltd.  
New Allenberry Works (Deepak Industries Ltd.)  
Niagara Gear Corp.  
Niebuhr Gears  
Nissei Corporation of America  
Nordex Inc.  
Northern Tool and Gear Co. Ltd.  
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Oerlikon Graziano SpA  
Omni Gear & Machine Corp.

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**Ontario Drive & Gear Ltd.**  
3551 BLEAMS ROAD  
NEW HAMBURG ONTARIO N3A 2J1, CANADA  
Phone: (519) 662-2840  
Fax: (519) 662-2127  
info@odg.com  
www.odg.com

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Onvio LLC  
Orlandi Gear Co.  
Overton Chicago Gear Corporation  
Overton Gear  
P. G. DRIVE  
PIC Design  
Peerless-Winsmith Inc  
Performance Gear Systems, Inc.  
Perry Technology Corp.  
Philadelphia Gear Corp.  
Pioneer Broach Co.  
Popular Mechanical Works  
Pragati Transmission Pvt Ltd  
Precipart  
Precision Gears Inc.  
Precision Screw Thread  
Precision Technologies Group (PTG) Ltd.  
Premier Machine & Gear Ltd.  
Process Gear  
Progressive Engineering Co.  
Pulley Manufacturers International Inc.  
Punjab Gears  
Purvis Industries  
Quality Reducer Service

**Quality Transmission Components - QTC Gears**  
125 RAILROAD AVE.  
GARDEN CITY PARK, NY 11040-5016  
Phone: (516) 437-6700  
Fax: (516) 358-9478  
QTCGearsSupport@qtcgears.com  
www.qtcgears.com/e-store

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**Bevel Gears (India) Pvt. Ltd.**



Bevel Gears (India) Pvt. Ltd.  
17 B Sadaramangla Industrial Area,  
Whitefield Road, Bangalore, 560048

P: +91 80 2841 0312 / 039  
F: +91 80 2841 0185  
E: jamalgrp@vsnl.com

www.bevelgearsindia.com

RJ Link International, Inc.  
Rave Gears LLC  
Redin Production Machine  
Reliance Gear Corp  
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#### Rexnord - Process and Motion Control

4701 W. GREENFIELD AVENUE  
MILWAUKEE, WI 53214-5310  
Phone: (414) 643-3000  
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[www.rexnord.com](http://www.rexnord.com)

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Riley Gear



#### Riverside Spline & Gear Inc.

1390 S. PARKER  
MARINE CITY, MI 48039  
Phone: (866) 306-0137  
Fax: (810) 765-9595  
[rfq@splineandgear.com](mailto:rfq@splineandgear.com)  
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Ronson Gears  
Rush Gears Inc.  
SDP/SI  
SEW-Eurodrive  
SIPCO-MLS  
SPN Schwaben Praezision  
SSJ Italy  
ST Gear & Machine LLC  
STD Precision Gear and Instrument  
Sam Gears India Pvt.ltd  
Schafer Gear Works, Inc.  
Schenck Trebel Corporation  
Shivam Autotech Ltd.  
Sokhi Heli-Wom Gears Pvt. Ltd.  
Sond Gears Pvt. Ltd.  
Southern Gear & Machine Inc.  
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Standard Machine  
Steelmanns Broaches Pvt Ltd  
Sterling Instrument

#### Stock Drive Products

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Suhner Manufacturing Corp.  
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Supreme Gear Co.  
Suzhou Asia Pacific Metal Co., Ltd.  
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Taiwan Precision Gear Corp.  
Taiwan United Gear Co., Ltd.  
Team Industries

#### Thermotech

1302 SOUTH 5TH STREET  
HOPKINS, MN 55343-7877  
Phone: (800) 735-1888  
Fax: (952) 933-9412  
[www.thermotech.com](http://www.thermotech.com)

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Toledo Gearmotor A Bluffton Motor Works Company  
Tool Masters India  
Torque Transmission  
Trojon Gear Inc.  
Tsubakimoto Chain Co.  
Unigear Industries

United Gear & Assembly Inc.  
V2 Engineering Systems  
VCST LP  
VW Broaching Service Inc.  
Vision Quality Components, Inc.  
WMH Transmissions Ltd  
Wilson Machine Co. Ltd.  
Winzeler Gear  
Wyko - London & Overseas Supplies  
Xubi Engranajes S.I.  
Yager Gear Enterprise Co. Ltd.

## GEARS

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ABL Products Incorporated  
AKGears, LLC  
ASI Technologies Inc.  
AST Bearings  
ATA Gears Ltd.  
Accent Bearings Co. Inc.  
Accurate Gear and Machine, Inc.  
Acme Gear Co.  
Adams Company  
Aero Gear Inc.  
Aerocom Industries Inc.  
Agro Engineers  
Akron Gear and Engineering  
Allen Gears Ltd.  
Allied Gear Co.  
Allied Specialty Precision Inc.  
American Gear & Engineering  
American Gear, Inc.  
American Plastics Depot  
American Swiss Products Co., Inc.  
Ameridrives Power Transmission  
Ametric / American Metric Corporation  
Ancon Gear & Instrument Corp.

#### Andantex USA Inc.

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Fax: (732) 493-2949  
[info@andantex.com](mailto:info@andantex.com)  
[www.andantex.com](http://www.andantex.com)

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Area Distributors Inc.  
Arrow Gear Co.  
Artec Machine Systems  
Ascent Precision Gear Corporation  
Ashot Ashkelon Industries Ltd.  
Atlanta Drive Systems Inc.  
Atlanta Gear Works, Inc.  
Autoparts Solutions Pvt. Ltd.  
Avion Technologies Inc.

#### B & R Machine and Gear Corp.

4809 U.S. HWY. 45  
SHARON, TN 38255  
Phone: (731) 456-2636 or (800) 238-0651  
Fax: (731) 456-3073  
[inquiry@brgear.com](mailto:inquiry@brgear.com)  
[www.brgear.com](http://www.brgear.com)

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B&B Manufacturing, Inc.  
BC Gear Inc  
BC Manufacturing  
BDI - Bearing Distributors Inc.  
Baker Bearing Company

#### Baldor Electric Company

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

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Bearings2000  
Beaver Aerospace and Defense Inc.  
Befared  
Beijing THC Limited

#### Bevel Gears India Pvt. Ltd.

17B SADARAMANGALA INDUSTRIAL AREA  
WHITEFIELD ROAD  
BANGALORE - 560048, INDIA  
Phone: +(91) 80-28410312  
Fax: +(91) 80-28410185  
[jamalgrp@bevelgearsindia.com](mailto:jamalgrp@bevelgearsindia.com)  
[www.bevelgearsindia.com](http://www.bevelgearsindia.com)

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Blaney Gears Ltd.  
Bonfiglioli Riduttori S.p.A.  
Boston Gear  
Bowmar LLC  
Brad Foote Gear Works, Inc  
Brelie Gear Company, Inc  
Brevini Power Transmission - Canada  
Brevini USA  
Brevini Wind USA  
Brewer Machine & Gear Co.  
Broach Masters / Universal Gear  
Broadway Gear  
Buffalo Gear, Inc.  
Butler Gear  
C-B Gear & Machine  
CIMA S.p.A.  
CNN Bearings  
Calicut Engineering Works Limited  
Capstan Atlantic  
Carnes-Miller Gear Co., Inc.  
Cattini & Figlio s.r.l.  
Central Gear & Machine  
Certified Reducer Builders Inc.  
Cha Industries, Inc.  
Chenta Gear - USA  
Chongqing Rainbow M&E Co., Ltd.  
Churon Co.  
Cincinnati Gearing Systems

#### Circle Gear & Machine Co.

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Fax: (708) 652-1100  
[circlegear@circlegear.com](mailto:circlegear@circlegear.com)  
[www.circlegear.com](http://www.circlegear.com)

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Clark Gear Works, Inc.  
Clarke Engineering Inc. (Clarke Gear Co.)  
Classic Gears and Machining  
Cleveland Gear Co.  
Cloyes Gear & Products Inc.  
Cogmatic, Inc.  
Columbia Gear Corp.  
Commercial Gear & Sprocket Co. Inc.  
Cone Drive Gearing Solutions  
Cotta Transmission Company  
Cross + Morse  
Curtis Machine Co. Inc.  
Custom Gear & Machine Inc.  
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D&D Power Transmission Products  
D.G. Steel & Son Engineering Ltd.  
Dalton Bearing Service, Inc.  
Davall Gears Ltd.  
David Brown Gear Systems Ltd.  
DePe Gear Company Ltd  
Delroyd Worm Gear  
Delta Dynamics Inc.  
Delta Gear Company  
Delta Gear Inc.  
Delta Research Corp.  
Drive Lines Technologies Ltd.  
Drive Systems



### Dunkermotoren USA Inc.

2511 TECHNOLOGY DRIVE, SUITE 105  
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Phone: (224) 293-1300  
Fax: (224) 293-1301  
john.morehead@dunkermotoren.com  
www.dunkermotor.com

Dynamic International Enterprise Ltd.  
EIC Industry Group  
EM Gear / Dae Seong Gear  
Elda Machining Co. Ltd.  
Electronic Machine Parts  
Emerson Industrial Automation  
Engranajes Masia, S.L.  
Essential Power Transmission Pvt. Ltd.

### Excel Gear, Inc.

11865 MAIN STREET  
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www.excelgear.com

Excel Industrial Gears Pvt. Ltd.  
FMC Engineering  
Federal Gear  
First Gear Engineering & Technology

### Forest City Gear Co.

11715 MAIN STREET  
ROSCOE, IL 61073  
Phone: (815) 623-2168  
Fax: (815) 623-6620  
rmikel@fcgear.com  
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GKN Driveline  
GMB Associates  
GMN Bearing Usa, Ltd.  
GTA Gear Technology & Applications BV  
Gajra Gears Pvt. Ltd.  
Gayatri Gear Industries  
Gear Design & Service Pty. Ltd.  
Gear Manufacturing Inc.  
Gear Master Inc.

### Gear Motions, Inc.

1750 MILTON AVENUE  
SYRACUSE, NY 13209  
Phone: (315) 488-0100  
www.gearmotions.com

Gear Technology

### Gear Works - Seattle, The

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SEATTLE, WA 98108  
Phone: (206) 762-3333  
Fax: (206) 762-3704  
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www.thegearworks.com

Gear World SpA

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GearVisions, Inc.  
Genemax Industrial Inc.  
Gerhardt Gear Co. Inc.  
Gleason K2 Plastics  
Goodwill Engineering  
Great Lakes Industry Inc.  
Griffin Gear Co.  
Groschopp Inc.  
Guardian Industries, Inc.  
H.H. Engineering Works  
HMC Inc.  
Halifax Rack & Screw Cutting Co. Ltd.  
Hankamp Gears  
Harmonic Drive LLC  
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Hayes Manufacturing Inc.  
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Horsburgh & Scott

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Houston Pump and Gear  
IBT, Inc

### IG Watteeuw

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IMO USA Corp.  
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Industrial Pulley & Machine Co, Inc.  
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Insko Corp.  
Intech Corporation  
Intecno USA  
Italgear S.r.l.  
JVL Industri Elektronik A/S  
Jahnel - Kestermann GmbH & Co. Kg  
JinHang Precision Bearing Co., Ltd  
Kamar Industries  
Kaydon Corporation Bearings Division

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### Kleiss Gears, Inc.

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Phone: 715-598-4492  
Fax: 715-463-5996  
drichter@kleissgears.com  
www.kleissgears.com

LYC North America Inc  
Link Gear & Machine Company  
Linn Gear  
Lnt India  
Luoyang Goldeng Slewing Ring Co., Ltd  
MECA & Technology Machine Inc.  
MMB Bearing Co. Inc.  
MT Tool & Manufacturing  
Magnum Manufacturing  
Marples Gears, Inc.  
Marswell Engineering Ltd.  
Martin Sprocket & Gear  
Merit Gear Corp.  
Micro Ingranaggi Standard sas  
Midwest Gear & Tool, Inc.  
Midwest Motion Products  
Mijno Precision Gearing  
Milwaukee Gear Co.  
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### Ontario Drive & Gear Ltd.

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PIC Design  
PUH Sprzet-Kop Rajmund Krakowski  
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Perry Technology Corp.  
Philadelphia Gear Corp.  
Plastock - Putnam Precision Molding, Inc.  
Popular Mechanical Works  
Portescap  
Pragati Transmission Pvt Ltd  
Precipart  
Precision Gears Inc.  
Precision Screw Thread  
Precision Technologies Group (PTG) Ltd.  
Premier Machine & Gear Ltd.  
Process Gear  
Progressive Engineering Co.  
Pulley Manufacturers International Inc.  
Punjab Gears  
Purvis Industries

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Ronson Gears

Rotek Incorporated  
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Sam Gears India Pvt.ltd  
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Schafer Gear Works, Inc.  
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Shivam Autotech Ltd.  
Silvertex Industrial (H.K.) Ltd.  
Siti Spa Riduttori  
Sokhi Heli-Wom Gears Pvt. Ltd.  
Sond Gears Pvt. Ltd.  
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Taiwan United Gear Co., Ltd.  
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Trojon Gear Inc.  
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U.S. Tsubaki Power Transmission, LLC  
Unigear Industries  
United Gear & Assembly Inc.  
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Valley Gear & Machine Inc.

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Amacoil, Inc.  
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Atlanta Drive Systems Inc.  
BDI - Bearing Distributors Inc.

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Bison Gear and Engineering Corp.  
Bosch Rexroth USA  
CUI Inc  
Certified Reducer Rebuilders Inc.  
Clarke Engineering Inc. (Clarke Gear Co.)  
Custom Gear & Machine Inc.  
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Dalton Bearing Service, Inc.  
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David Brown Gear Systems Ltd.  
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Festo Corporation

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Tsubakimoto Chain Co.  
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Ultra Motion  
VL Motion Systems Inc.  
WMH Transmissions Ltd  
Warner Linear  
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Wittenstein (formerly alpha gear drives)  
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Yaskawa America, Inc. - Drives & Motion Divisi  
Zero-Max

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Arc Systems, Inc.  
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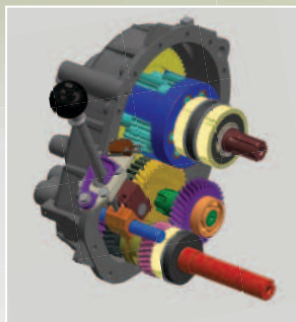
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Electronic Machine Parts

## RESOURCES

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American Bearing Manufacturers Association  
IDC-USA  
PTDA - Power Transmission Distributors Association  
Power-Motion Technology Representatives Association  
SMMA - The Motor and Motion Association

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Promess Inc.  
Purvis Industries  
Rdf Corporation  
Redex Andantex  
RoMaDyn - Rotating Machinery Engineering Services  
Rockwell Automation  
Rowland Co., The  
Scancon Encoders  
Schenck Trebel Corporation  
Schneeberger Inc.  
Sensor Products Inc.  
Sensor Technology Ltd.  
Source Engineering Inc.  
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Stellar Technology, Inc.  
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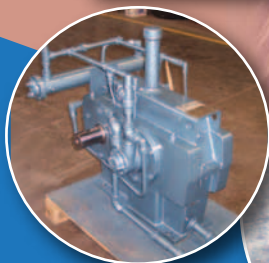
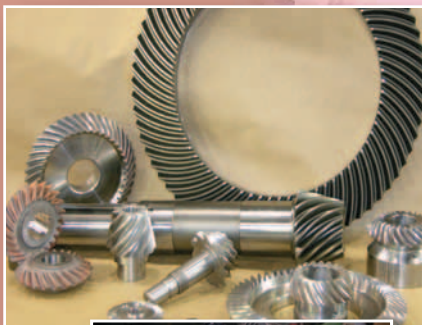
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# Siemens Industry, Inc.

KICKS-OFF ENERGY INITIATIVE, ACQUIRES LMS

Siemens Drive Technologies has kicked off its Integrated Drive Systems initiative to highlight the energy efficiency benefits of its comprehensive and custom engineered product and service offerings, including gearboxes, couplings, motors and drives through a single source. The program offers end users, EPCs and OEMs the ability to reduce operational costs and improve engineering effectiveness. Siemens plans to focus its integrated drive systems program on vertical markets for oil and gas and mining and cement industries. Additionally, Siemens will support integrated drive systems in other markets, such as metals, power generation, water/wastewater, pulp and paper and general manufacturing. Doug Keith, president of Siemens Drive Technologies Division, highlighted several benefits of integrated drive systems. "Our integrated drive systems help to simplify the vendor process to maximize existing design specifications, yet ensure that projects are engineered without a waste of dollars, time and resources. Additionally, we are able to increase the speed and implementation of project development and commissioning, enhance design efficiencies and ensure the best, and most appropriate, components throughout the system," says Keith.

Siemens will support its Integrated Drive Systems initiative with a global team of trained and certified industry experts who handle consultation and proposals, delivery, installation, maintenance and service. The company will incorporate *PM@Siemens* within the offering, an extensive global training and certification program with methodology based on the essential success factors for project management. And, the company can fully support customized configurations for integrated drive systems; with its localized manufacturing and service footprint, customer needs are quickly met.

Siemens Drives Technologies Division has four primary U.S. manufacturing facilities, including Elgin, Illinois for gearboxes and couplings; Norwood, Ohio for motors; New Kensington, Pennsylvania for medium voltage drives; Alpharetta, Georgia, for low voltage and traction drives; and Houston, Texas for sales support.

In other news, Siemens recently expanded its portfolio of

industry software by acquiring LMS International NV (Leuven, Belgium), a provider of test and mechatronic simulation for complex products. "The mechatronic simulation will become more and more important for intelligent and competitive product development and production processes. With the acquisition of LMS we are entering a leading position in this software segment as well, and can significantly boost the pace and power of our clients' innovation," said Siegfried Russwurm, member of the Siemens AG Managing Board and CEO of the Industry Sector. The purchase price for LMS amounts to approximately 680 million euro. The transaction is subject to approval by regulatory authorities. With more than 1,200 employees and revenues of around 140 million euro for the first nine months of 2012 (January 1 to September 30), LMS is a global partner to some 5,000 companies in the automotive, aerospace and other industries. The privately held company is supporting all of the Fortune 500 automotive and aerospace manufacturers and their tier-one suppliers with a combination of mechatronic simulation software, testing systems and engineering services.

LMS offers a complete software platform to model, simulate and test vehicles, aircraft and other complex products, optimizing their acoustics, vibrations, oscillations, fatigue strength and dynamics. The business activities of LMS are to be integrated into the product lifecycle management (PLM) software portfolio within the Siemens Industry Automation Division. "With the acquisition of LMS, we are expanding our portfolio of industry software in an area that is critical for many customers. They will now be able to simulate, test, optimize and produce their products in a unified, consistent data environment. This will make them faster, more efficient, more flexible and more cost effective," explains Anton S. Huber, CEO of the Industry Automation Division.





# Bosch Rexroth

## OPENS NEW CHINA PLANT

Bosch Rexroth has taken a new plant into operation in Wujin, China, which employs approximately 1,200 associates. In order to react to the special regional requirements even faster, the local development activities will be bundled in an internal R&D center starting in 2013. Overall, the company will invest €83 million in the expansion of its presence in the region. Bosch Rexroth produces hydraulic, linear motion technology, and pneumatics components and systems in Wujin.

“Our ‘local for local’ strategy will help us tap additional market segments that could not be reached from Germany. In the long run, this will also ensure higher utilization at the German plants,” said Dr. Bertram Hoffmann, member of the board of Bosch Rexroth AG, before numerous representatives from politics and the economy. “But in addition to production, we will also establish an R&D center in Wujin, mainly for industrial automation,” affirmed Fo Wai Lau, managing director of Bosch Rexroth in China. Here, engineers are developing regional variants based on the German product platforms that meet the requirements of the company’s local customers.

Bosch Rexroth has been present in China for more than 30 years and is continuously expanding the local value creation. Last year, the company has made almost €1 billion in sales in China and has thus more than quadrupled its business volume since 2005. The company employs a total of about 3,900 staff in China. Most of the components and systems from the new plant with a total area of about 70,000 square meters are supplied to the largest global market for all kinds of machines.



One focus, for example, is on system solutions for more energy efficiency. Machine concepts developed in close collaboration with Chinese manufacturers consume up to 50 percent less energy while offering the same level of productivity. All experts agree that China will be achieving clearly higher growth rates than Europe or America over the next decade.

The plant in Wujin is part of Bosch Rexroth’s global growth strategy. Over the past years, the company has, for example, also expanded its capacities in North and South America, Eastern Europe and India.

“We are striving to achieve a balanced revenue distribution among the markets of the triad to be able to better compensate for regional fluctuations,” said Hoffmann.

# Parker Aerospace

## FORMS JOINT VENTURE WITH GE AVIATION

Parker Aerospace and GE Aviation recently announced that they have reached an agreement to form a joint venture, Advanced Atomization Technologies, LLC, to enhance the development and manufacture of commercial aircraft engine fuel nozzles. This represents a critical addition to the comprehensive GE fuel management team. The 50-50 joint venture — created specifically to produce fuel nozzles for current and future GE Aviation commercial engine platforms (including aerospace and aero-derivative engines) — will be located in the Parker Gas Turbine Fuel Systems Division facility in Clyde, New York. The joint venture will employ approximately 300 skilled assemblers, technicians, engineers, and other professionals in the production of advanced fuel nozzles and related products for GE Aviation. (No financial information on the joint venture has been disclosed.) “GE and Parker Aerospace are both world-class aviation businesses and this joint venture will allow us to further evolve our existing relationship and offer best-in-class design, manufacturing and program management for these critical components,” said Mike Sims, GE Aviation Combustor General Manager. Continuing its long history in the Clyde community,

the facility will be a center of excellence in lean manufacturing and fuel-nozzle development. Leanne Collazzo, current site leader of the Parker facility, has been named the general manager for the new Advanced Atomization Technologies, LLC. “Parker is excited to enter into a joint venture with GE Aviation to ensure the future of the Clyde facility through growth and increased synergy with our customer,” said Manuel Bajaksouzian, General Manager of the Parker Aerospace Gas Turbine Fuel Systems Division. Pairing Parker’s fuel nozzle technology and GE’s advanced TAPS combustion technology will dramatically reduce engine emissions while increasing fuel efficiency; two of the most important elements for enhanced engine performance. Joint development and manufacturing expertise will result in superior fuel nozzles in future products. GE Aviation is currently developing a new family of engines for the aerospace industry including LEAP (in partnership with Snecma), GE9X and Passport. These important new programs are expected to fuel growth for the joint venture and generate strong production orders and a robust services business.

# AMT

## REPORTS TOTAL 2012 MANUFACTURING ORDERS UP

October U.S. manufacturing technology orders totaled \$459.16 million according to the Association for Manufacturing Technology (AMT). This total, as reported by companies participating in the United States Manufacturing Technology Orders (USMTO) program, was down 31.3 percent from September and down 0.1 percent when compared with the total of \$459.41 million reported for October 2011. With a year-to-date total of \$4,753.68 million, 2012 is up 5.3 percent compared with 2011. These numbers and all data in this report are based on the totals of actual data reported by companies participating in the USMTO program.

"Orders continue to be on pace for a record-setting year, and a monthly drop was fully expected in the month following IMTS," said Douglas K. Woods, AMT president. "While manufacturing continues to play a strong role in economic recovery, our main concern heading toward the end of the year is that lawmakers do what's necessary to avoid the fiscal cliff, and the implications it could have on the broader economy."

The USMTO report, compiled by the trade association representing the production and distribution of manufacturing technology, provides regional and national U.S. orders data of domestic and imported machine tools and related equipment. Analysis of manufacturing technology orders provides a reliable leading economic indicator as manufacturing industries invest in capital metalworking equipment to increase capacity and improve productivity. U.S. manufacturing technology orders are also reported on a regional basis for five geographic breakdowns of the United States:

### Northeast Region

Manufacturing technology orders in the Northeast Region in October totaled \$63.69 million, down 19.7 percent from September's \$79.27 million and down 3.6 percent when compared with the October 2011 figure. At \$640.83 million, 2012 year-to-date is down 5.7 percent when compared with 2011 at the same time.

### Southern Region

Southern Region manufacturing technology orders totaled \$60.69 million in October, down 41.1 percent from the \$102.99 million total for September but 12.8 percent higher than the total for October 2011. The year-to-date total of \$683.23 million is 15.3 percent more than the comparable figure for 2011.

### Midwest Region

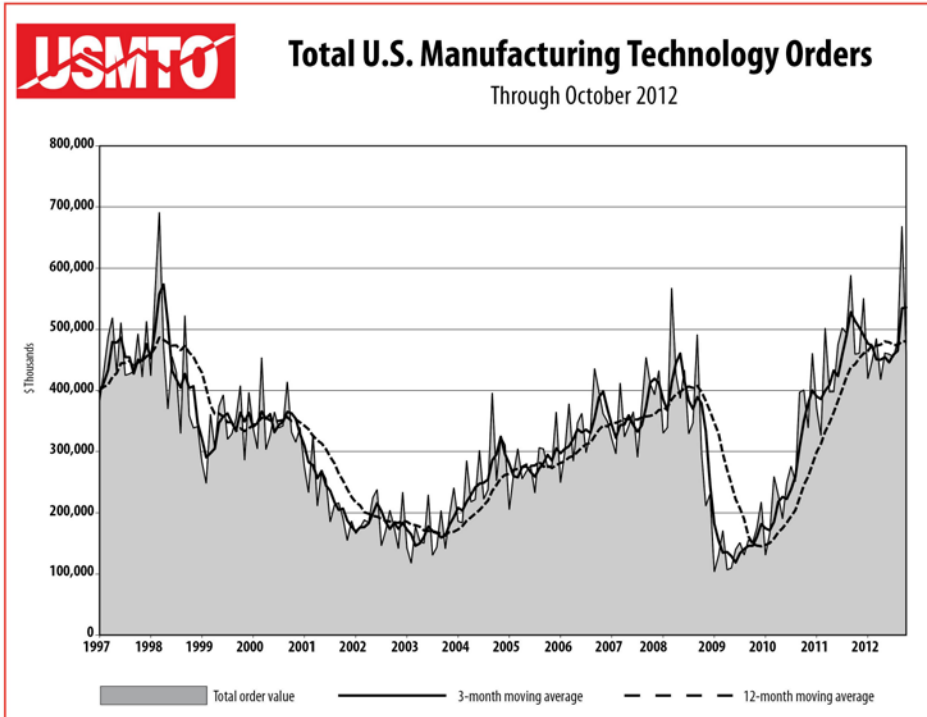
At \$162.75 million, October manufacturing technology orders in the Midwest Region were down 20 percent when compared with the \$203.33 million total for September but up 10.3 percent when compared with October a year ago. With a year-to-date total of \$1,530.30 million, 2012 is up 4.9 percent when compared with 2011 at the same time.

### Central Region

October manufacturing technology orders in the Central Region totaled \$124.77 million, 30.2 percent lower than September's \$178.71 million and down 8.8 percent when compared with the October 2011 figure. At \$1,341.76 million, the 2012 year-to-date total was 6.8 percent more than the comparable figure for 2011.

### Western Region

Western Region manufacturing technology orders in October stood at \$47.27 million, down 54.6 percent from the September total of \$104.07 million and 14.3 percent lower than the figure for October 2011. The \$557.56 million year-to-date total was 5.7 percent above the total for the same period in 2011.



## Vacon

### ESTABLISHES SINGAPORE REGIONAL CENTER

Global AC drives manufacturer Vacon has established a regional center in Singapore. The new center started operations in August 2012. Vacon's regional center in Singapore ensures that Vacon's entire product portfolio and service network offering are available to customers in the region. The center is also in charge of effective sharing of best practices, know-how and the professional personnel that the company already has in the Middle East, India, South East Asia and Pacific region. This will open up new opportunities for Vacon to gain market share and increase volumes in this region with its huge population and great market potential.

"As a major world trade node with a business-friendly economy, Singapore was a logical location for Vacon to establish a regional center. We are at the heart of the region which is one of Vacon's major growth areas," says Olli Tev , Vacon's vice president for Middle East, India, SEA, Pacific. "Singapore has also a rich supply of skilled and experienced workers, which will help us to continuously improve our customer service in the region. As many of Vacon's global customers have their regional offices in Singapore, it will help us in building seamless cooperation with them. This also reflects Vacon's values: keeping customers and partners at the heart of Vacon's operations," concludes Tev .

## IEEC

### PRaises INDUSTRIAL EFFICIENCY LEGISLATION

The Industrial Energy Efficiency Coalition (IEEC) praised House passage of H.R. 6582, the American Energy Manufacturing Technical Corrections Act. "There are huge gains in industrial energy efficiency that we are leaving on the table by not addressing the inefficiencies in many manufacturing and industrial processes," said Paul Hamilton, chair of the IEEC. "Policies such as this are helping to understand and tackle these industrial energy efficiency opportunities." The bill directs the Department of Energy (DOE) to establish collaborative research and development partnerships with other programs to support the use of innovative manufacturing processes and to support applied research for development, demonstration, and commercialization of new technologies and processes to improve industrial efficiency. "Ensuring that all industrial energy-saving technologies are fully incorporated into the Department of Energy's activities is critical," Hamilton said. Energy intensive manufacturers have long been aware of the cost of inefficient energy use and have made major investments in sensors, controls, and automation to reduce their energy costs. "The challenge now is to drive awareness and deployment of these energy efficiency opportunities across the entire manufacturing sector, especially into the less energy intensive sites which represent some 150,000 facilities across the United States," said Bruce Quinn, a founding member of the IEEC.

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# PTDA

## Wraps Up 2012 with Successful Industry Summit

The PTDA Industry Summit, held on October 18-20, 2012 in Dallas, Texas, featured more than 700 participants for two-and-a-half days of networking opportunities and good old-fashioned Texas-style fun. The event kicked off with a Motion Control Showcase featuring 18 exhibitors displaying their products to existing and potential customers. This was followed by the First-Timer Event, which gave seasoned experts the chance to offer Industry Summit newcomers advice and tips for making the most of the conference. Also on the conference's opening night, a Next Gen After Party offered attendees age 40 and under the opportunity to catch up with peers and participate in a mixology competition.

To better promote peer-to-peer networking, the Industry Summit featured a Distributor Forum and a Manufacturer Forum. In each of these forums, distributors and manufacturers separately tackled issues that affect the distributor-manufacturer relationship. Nearly 120 manufacturers exhibited at MD-IDEX (Manufacturer-Distributor Idea Exchange), where supply chain partners met face to face in over 600 scheduled and open appointments and engaged in focused, one-on-one group discussions about how to work together.

The conference came to a close with a unique Dallas experience as every delegate had the opportunity to see Cowboys Stadium from a viewpoint usually reserved for the NFL players—from the field. Attendees began their evening by entering the stadium through the Miller Lite Club, the same way the Cowboys enter the stadium on game day. A reception was held right on top of the Cowboys Lone Star at the 50-yard line, and sponsor logos lit up the enormous DiamondVision screen. Attendees showed off their team pride by wearing jerseys from their favorite teams. Admittedly, not all of the jerseys were from the NFL, but team

rivalries were most evident—including Chicago Bears and Detroit Lions fans.

Dinner featured outstanding Texas barbecue items served right on the field. During and after dinner, two Dallas Cowboys Cheerleaders posed for photos with attendees and their guests. Attendees also had an opportunity to show off their skills by running an agility drill, throwing footballs or kicking one through the uprights.

### PTDA 2012 Industry Summit at a Glance

- Themed “Big Ideas to Steer Your Business.”
- Total attendance was 715, which included 570 industry delegates.
- Overall delegate participation was up 9 percent over 2011 attendance. Additionally, distributor attendance showed an increase over last year of 12 percent for individual delegates and 10 percent for companies represented, compared to 2011 numbers.
- International delegates from Argentina, Belgium, Canada, France, Germany, Italy, Japan, Mexico, the Netherlands, Trinidad and Tobago, and the United Kingdom attended.

### Industry Summit Highlights

Opening keynote address by Scott Klososky, “Trends, Technology & Taking the Lead.”

- Second keynote address by Alan Beaulieu of the Institute for Trend Research, “The Beaulieu Report.”
- Workshop: “The Changing Sales Model” by Scott Klososky.
- Workshop: “Knowledge Transfer and the Emerging Generations” by Bob Wendover of the Center for Generational Studies.

### Next Stop: Spring Leaders Conference

The PTDA will be hosting its annual Spring Leaders Conference March 21-23, 2013, in San Antonio, Texas. The



Spring Leaders Conference includes: committee meetings for PTDA volunteers and elected directors, a general educational session for all PTDA members and the Leadership Development Conference. Featured in the general educational session is Kevin Boyle, president, Industrial Distribution Consulting, LLC, a widely recognized expert in the field of distributor and manufacturer business relationships. Boyle's interactive program, “Building Profitable Partnerships Between Distributors and Manufacturers Through Understanding,” enables participating supply chain partners to dig into the details of how to improve through true value-added programs and hot-button issues.

Randy Disharoon, a strategic account manager with Rexnord Industries, LLC, and former U.S. Navy nuclear engineer and trainer, will be leading the day-long Leadership Development Conference component of the PTDA 2013 Spring Leaders Conference. Disharoon's program, “Developing Leaders for What's Next in the PT/MC Distribution Sales Channel,” prepares up-and-coming leaders for changes in the marketplace, communications strategies and the world of globalization with sessions, self-evaluations and interactive exercises participants will undertake together and separately to bring out the best leadership qualities in each other.

To register for the Spring Leaders Conference, visit [www.ptda.org/springleadersconference](http://www.ptda.org/springleadersconference). **PTE**

**January 21–24—Automate 2013.** McCormick Place, Chicago. Automate is the largest solutions-based showcase of automation technologies in North America. Formerly the International Robots, Vision & Motion Control Show, which dates back to 1977, Automate now demonstrates the full spectrum of automation technologies and solutions for a broad array of industries. The show is held once every two years. Companies that provide integration of automation, robotics and machine vision will show actual demonstrations of systems at the show. This allows attendees to see live demos solving challenges they face in their industry, and also to learn from solutions used in other industries that may be beneficial to them. The rest of the show features the latest automation, robotic, vision and motion control technologies and systems on display from leading global suppliers. A comprehensive educational conference accompanies the Automate show. Featuring a broad array of classes from beginner to advanced skill levels, the conference offers something for all attendees—they can take one class or four full days of training. ProMat, a material handling and logistics show, is co-located with Automate 2013. For more information, visit [www.automate2013.com](http://www.automate2013.com).

**February 7–8—Motor and Drive Systems 2013.** Orlando, Florida. Motor & Drive Systems 2013 is an international conference focused on the latest growth trends and technical advancements impacting motor and drive systems. Join hundreds of peers and potential business partners and discover how new technologies are improving performance, energy efficiency and providing cost savings in a variety of applications. This annual conference will feature more than 25 presenta-

tions on new motor and drive technologies and design considerations, motion control, power electronics/modules and components. Sessions will also cover market trends and growth areas as well as regulatory and safety issues. The event serves technical and management professionals involved in all sectors of motor, drive and motion control technologies including OEMs, end users, integrators and dealers. The conference provides the best forum to learn from leading motor and drive system manufacturers on new technologies entering the market and what's ahead. Newsworthy additions to the 2013 show include new motor technologies and applications, an OEM design engineer panel, magnetic manufacturer panel, regulatory and safety issues and design and development of motor and drive systems. For more information, visit [www.e-driveonline.com](http://www.e-driveonline.com).

**March 12–14—Gearbox CSI-Forensic Analysis of Gear and Braking Failures.** Hyatt Regency Baltimore on the Inner Harbor, Baltimore, Maryland. Determining the cause of a failure in a gearbox is like a “whodunnit” mystery. What caused the failure: The bearings, a gear, the lubrication or a shaft problem? Where do you start, and how can you tell? Instructors Raymond Drago and Joseph Lenski, Jr. from Drive Systems Technology, Inc. will help gear designers gain a better understanding of various types of gears and bearings. Learn about the limitation and capabilities of rolling element bearings and the gears that they support so you can properly apply the best gear-bearing combination to any gearbox, whether simple or complex. A certificate will be awarded upon completion of the seminar. For more information, visit [www.ptma.org](http://www.ptma.org).

### **March 19–21—AeroDef Manufacturing 2013.**

Long Beach, California. AeroDef Manufacturing is an exposition and technical conference for the aerospace and defense manufacturing industry. Produced by the Society of Manufacturing Engineers (SME), in partnership with industry OEMs, the show's mission is to foster innovation across the extended enterprise to reduce costs, expedite production times and maintain manufacturing competitiveness in the global economy. AeroDef showcases the industry's most advanced technologies across an innovative floor plan designed to facilitate interaction and business relationships between exhibitors and buyers looking for integrated solutions. Keynote speakers and panelists come from the highest level of government and business. They come to share their vision of the potential of technology, collaboration and public policy to transform manufacturing – concepts that attendees can actually experience on the exposition floor. AeroDef is co-located with Composites Manufacturing 2013. For more information, visit [www.aerodefevent.com](http://www.aerodefevent.com).

**March 21–23—PTDA Spring Leaders Conference.** Hotel Contessa, San Antonio, Texas. The three components of the Spring Leaders Conference include governance meetings for PTDA committees, the Leadership Development Conference and a General Educational Session. Kevin Boyle, president of Industrial Distribution Consulting, LLC, will present a three-hour interactive workshop focused on the power transmission distribution channel. Randy Disharoon, strategic account manager of Rexnord Industries, LLC will present a workshop on developing leaders in the PT/MC distribution sales channel. For more information, visit [www.ptda.org](http://www.ptda.org).



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# Power Transmission Engineering



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(Please print e-mail address)
- 3) Name: \_\_\_\_\_ JobTitle/Position: \_\_\_\_\_  
(print)
- 4) Signature \_\_\_\_\_ Date: \_\_\_\_\_

### 5) Please tell us about your company:

Company Name: \_\_\_\_\_  
Company Address: \_\_\_\_\_  
City: \_\_\_\_\_  
State/Province: \_\_\_\_\_  
ZIP/Postal Code: \_\_\_\_\_  
Telephone: \_\_\_\_\_ Fax: \_\_\_\_\_  
E-mail: \_\_\_\_\_  
Co. Internet Address: \_\_\_\_\_

### 6) How is THIS LOCATION involved with power transmission products?

(Check all that apply)

- ☐ WE MAKE power transmission products (10)  
☐ WE BUY power transmission products (12)  
☐ WE SELL power transmission products (Distributors, sales reps. etc.) (14)  
☐ WE DESIGN products with power transmission components in them. (16)  
☐ Other (please describe) (15) \_\_\_\_\_

### 7) Which of the following products and services do you personally specify, recommend or purchase? (Check all that apply)

- |  |  |  |
|--|--|--|
| <input type="checkbox"/> Actuators (30)                        | <input type="checkbox"/> Clutches (35)             | <input type="checkbox"/> Gear Mfg. Services (41) |
| <input type="checkbox"/> Adjustable-Variable Speed Drives (31) | <input type="checkbox"/> Controls (36)             | <input type="checkbox"/> Hydraulic Power (42)    |
| <input type="checkbox"/> Bearings (32)                         | <input type="checkbox"/> Chain & Chain Drives (37) | <input type="checkbox"/> Linear Motion (43)      |
| <input type="checkbox"/> Belting and Belt Drives (33)          | <input type="checkbox"/> Couplings & U-Joints (38) | <input type="checkbox"/> Motors (44)             |
| <input type="checkbox"/> Brakes (34)                           | <input type="checkbox"/> Gears (39)                | <input type="checkbox"/> PT Accessories (45)     |
|  | <input type="checkbox"/> Gear Drives (40)          | <input type="checkbox"/> Sensors (46)            |

### 8) What is your primary job function responsibility? (Check one)

- |  |   |
|--|---|
| <input type="checkbox"/> Corporate Management (1)      | <input type="checkbox"/> Purchasing (6)         |
| <input type="checkbox"/> Plant Engineering (2)         | <input type="checkbox"/> Quality Control (7)    |
| <input type="checkbox"/> Design Engineering (3)        | <input type="checkbox"/> Factory Automation (8) |
| <input type="checkbox"/> Marketing & Sales (4)         | <input type="checkbox"/> Maintenance (9)        |
| <input type="checkbox"/> Manufacturing Engineering (5) | <input type="checkbox"/> Other (10) _____       |

### 9) How many employees are at THIS LOCATION (Check one)

- ☐ 1-19 ☐ 20-49 ☐ 50-99 ☐ 100-499 ☐ 500+

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# THE MORE YOU ROCK

## THE MORE YOU ROCK AND ROLL!

### The concept is simple enough.

Take the traditional rocking chair, the one you'd find on a front porch or the corner of the living room, and give it a 2012 twist. iRock is a power-generating rocking chair that can also charge your iPhone or iPad.

iRock is equipped with a generator that transforms the rocking motion into power. If that's not enough technology for you to digest, the chair also comes equipped with a set of speakers built into the backrest. The more you rock, the more battery life you're giving to your smartphone or tablet device.

In the old days, the only constructive thing you could do on a rocking chair was whittle wood or take a nap.

Developed by Micasa Lab in Zurich, the iRock makes the age-old oak rocking chair significant again. It boasts a self-sufficient iPad dock and sound station. For the furniture enthusiast, the chair is handcrafted out of Swedish

pine wood and comes in five different colors.

While we applaud its ingenuity, the iRock project didn't get off the ground so well. According to the company's website, it was a challenge at first to get the generator to work. The Micasa team originally used rubber bands and springs to increase the effect of the movement but ended up with a solution using a winding mechanism that is "geared up" to run the generator.

Essentially, the engineering team explored how to collect energy, particularly from movement and friction, and harness it in some form (a 60 minute rocking session, for example, can recharge an iPad up to 35 percent).

In spending many long nights attempting to solve the power generation issues, the Micasa engineers came up with similar mechanisms that can



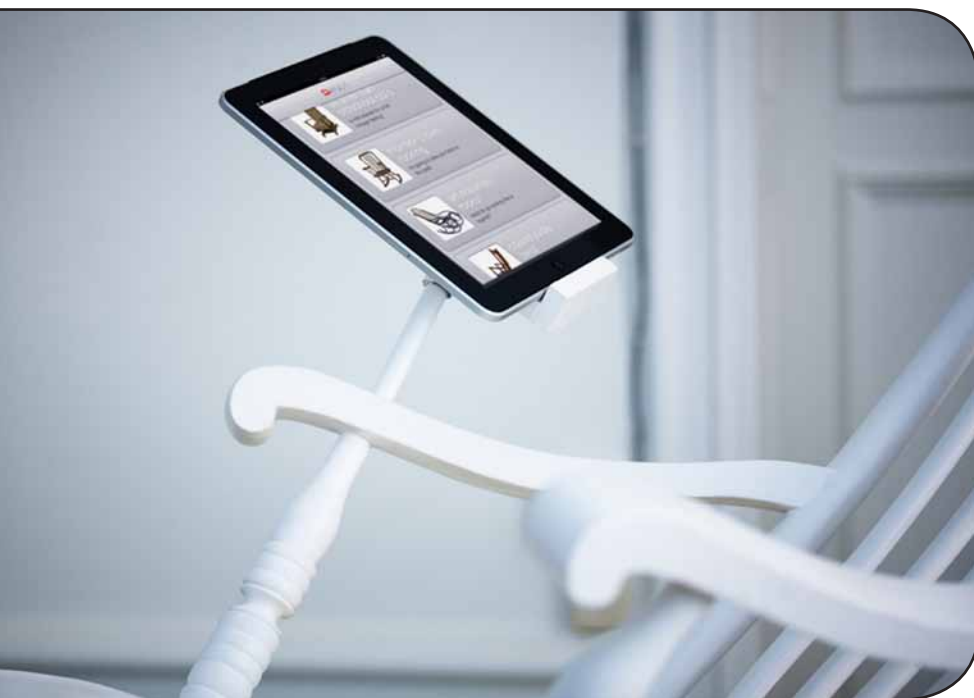
be applied to doors, drawers and stairs. Soon, something as simple as closing a door might be able to support power generation.

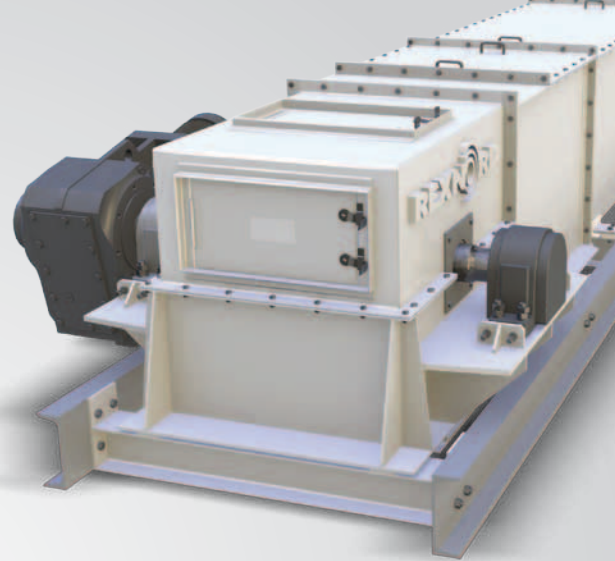
### And the drawbacks?

Currently the iRock is only compatible with Apple devices. If you're an Android user--well, you're just another guy/gal sitting in a rocking chair. The price tag, (iRock retails for \$1,300 online) also seems a bit steep. For that kind of money, the Power Play team would like the iRock to heat the house or perhaps power a flat screen television.

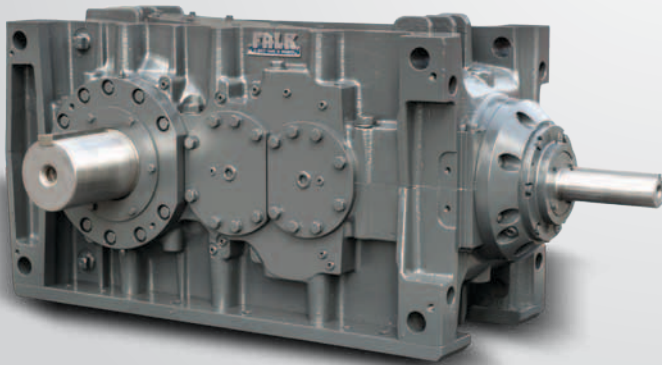
Still, the iRock hands down beats typical gift-giving fare like the necktie, Argyle socks or a Wisconsin cheese platter.

We publish in Chicago Bears country, after all! **PTE**





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