

Power Transmission Engineering®

AUGUST 2013

GEAR EXPO 2013

EXHIBITOR INTERVIEWS | BOOTH LISTINGS

FLEXIBLE OPTIONS WITH
FLEXIBLE SHAFTS

MEDICAL MOTION
CONTROL

Technical

[Fretting: Fanfare for
a Failure Mode]

[Brushing Up on DC
Motors]

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AUGUST 2013



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GEAR EXPO 2013

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Power Transmission Engineering

VOL. 7, NO. 4

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Trade Show Coverage

Our Gear Expo content can be found inside the latest issues of *Power Transmission Engineering* and *Gear Technology*. We also deliver booth preview information, educational opportunities and exhibitor interviews on our Twitter, LinkedIn and Facebook pages.

PTE Videos: Motion Industries latest MiHow2 video with Rexnord is currently featured on the *Power Transmission Engineering* home page (www.powertransmission.com). The video "How to Properly Relubricate Solid Housed Industrial Ball and Roller Bearings" takes viewers through the "Clear Method" according to Randy Breaux, senior vice president of marketing, product management and strategic planning at Motion Industries.



PTE Calendar: Our comprehensive online calendar/event section offers a place to let *PTE* readers know about your upcoming trade show, seminar, gear school or other calendar item. Send your press releases to Matthew Jaster at mjaster@powertransmission.com.



LinkedIn: The latest discussions on the PTE Group page includes coupling technology from R+W, SKF president Tom Johnstone discussing half-year results and gearbox efficiency factors from Groschopp. Join the discussion at: http://www.linkedin.com/groups?home=&gid=2950055&trk=anet_ug_hm.

Ask the Expert:

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

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Power Transmission Engineering

Randall Publications LLC

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

EDITORIAL

Publisher & Editor-in-Chief

Michael Goldstein
publisher@powertransmission.com

Managing Editor & Associate Publisher

Randy Stott
wrs@powertransmission.com

Senior Editor

Jack McGuinn
jmcguinn@powertransmission.com

Senior Editor

Matthew Jaster
mjaster@powertransmission.com

Editorial Consultant

Paul R. Goldstein

ART

Art Director

David Ropinski
dropinski@powertransmission.com

ADVERTISING

Advertising Sales Manager & Associate Publisher

Dave Friedman
dave@powertransmission.com

Materials Coordinator

Dorothy Fiandaca
dee@randallpublications.com

CIRCULATION

Circulation Manager

Carol Tratar
subscribe@powertransmission.com

RANDALL PUBLICATIONS STAFF

President

Michael Goldstein

Accounting

Luann Harrold



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Gear Expo – Gear Buyers' Bonanza



If you're reading this magazine, there's a good chance you're somehow involved in the design, specification or purchase of gears or geared products. As such, I urge you to make plans now to attend Gear Expo in Indianapolis, September 17-19.

Many of you probably think of Gear Expo as a show for manufacturers. And it is, of course. All the leading suppliers of gear manufacturing machine tools, cutting tools and services will be there—not to mention the fact that the show is again co-located with ASM's Heat Treating Society Conference and Exposition. If you manufacture gears, you already *know* how important Gear Expo is.

But Gear Expo is also an important trade show for gear buyers. The reason it's important begins with all of those machine tools and cutting tools. Even though you're not (necessarily) buying those machine tools, understanding how gears are made is crucial to making smart decisions when buying them. Nowhere else can you get a better understanding about the technology of gear manufacturing than at Gear Expo. Very often, the latest technologies open up new design opportunities, and understanding those opportunities will make you a better gear designer, specifier or buyer.

Even more importantly, the number of gear manufacturers exhibiting at Gear Expo has grown substantially. In 2011, about 50 gear manufacturers exhibited at the show. This year, there are 75, and whether you need large-diameter girth gears, fine-pitch medical components, plastic gears or powder metal, you'll find a selection of potential suppliers at Gear Expo. Many of these gear manufacturers are eager to talk with new potential customers, as evidenced by our interviews with exhibitors beginning on page 22. (*For a complete listing of gear and gear drive suppliers at the show, see page 30.*)

What can you hope to learn from these gear manufacturers? Of course, you'll learn about their capabilities, their manufacturing technology and their past work. But you'll also get a better sense of their backlog, turnaround time and quality systems. All of this will give you a better feel for the types of components each manufacturer does best, and you'll walk away with a much better idea of the suppliers who are the best fit for your needs.

Between the machine tool suppliers and the gear manufacturers who exhibit, Gear Expo offers the best of both worlds, particularly if you're in the position of having to decide whether to manufacture gears in-house or outsource them. So if gears or gear drives are a substantial part of your company's products, you owe it to yourself to attend this year's show. There is no better opportunity in North America to access the gear industry all in one place.

Of course, we'll be at the show as well, so please stop by Booth #1123 and see us. We invite you to stop by for a free cup of espresso, cappuccino or latte while you visit with our editors. We'd love to get your feedback regarding the magazine, our website and e-mail newsletters.

A handwritten signature in black ink that reads "Randy Stott". The signature is written in a cursive, flowing style with a large, prominent "R" and "S".



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R+W

INTRODUCES SURVIVOR SERIES OF FLEXIBLE DISC PACK COUPLINGS

The concept of fatigue resistance in flexible shaft coupling design has been highly valued by R+W since its inception in 1990. For much of its first two decades in business the company focus was almost exclusively on couplings for high performance servo drive technology. When it comes to machinery that utilizes this type of equipment, professionals at all levels know that shut down for maintenance can be extremely costly, and that unplanned downtime can have catastrophic effects on the profitability of a process. When properly applied, the flexible bellows coupling addresses this and a great number of other concerns in support of high speed, high accuracy machinery. In addition to fatigue resistance it offers the benefits of high torsional stiffness, low moment of inertia, and continuous symmetry, all of which lend themselves very well to motion systems involving rapid indexing and high precision positioning - essentially making it the first choice for servo drives. As R+W has continued to grow and add couplings for higher powered industrial drives to its portfolio, the need for a different type of fatigue resistant metallic coupling has become apparent. In 2013 R+W is introducing its Survivor series of flexible disc pack couplings. Not to be confused with a servo coupling, the flexible disc pack coupling is suited for many of the most demanding industrial power transmission systems.

More than just servo driven machinery demands reliable performance. Engineers in the petrochemical, power generation, steel and paper industries, to name a few, might consider that to be a laughable statement, and might also agree that reliable operation of their equipment is more critical today than ever. Designed to protect drive shafting, bearings and gears from stress related to misalignment and structural changes, a flexible shaft coupling is necessarily subject to a very large number of bending cycles in its life. More traditional designs require either periodic lubrication or replacement of wear parts in order to help relieve this kind of stress. But this kind of frequent maintenance is simply unacceptable in some critical installations. Metallic flexible couplings are a category which is typically designed with the intent to fully eliminate wear, based on the principle of fatigue resistance.

Material fatigue results from a certain number of stress cycles at a certain stress amplitude. In a flexible coupling this



Disc pack couplings are well suited for demanding power transmission applications.

essentially means the number of shaft rotations at certain levels of misalignment and torque. In the case of ferrous materials, when the stress amplitude is known and kept below the fatigue limits of the flexible element in the coupling (i.e. the misalignment and torque ratings), any number of cycles can be tolerated without fatigue. The goal is infinite life for the product.

R+W has been applying this concept to maintenance free bellows couplings for many years on its mission to deliver efficiency through coupling design. While the metal bellows coupling is often scaled up into the megawatt drive power ranges for applications which demand its specific characteristics, many industrial drive applications do not involve the dynamic motion profiles of servo systems, and tend more toward continuous forward rotation. In this category, as loads become larger and drivelines more power dense, a different set of shaft coupling characteristics can come into focus as being more suitable. There are some distinct features of the R+W version of the steel disc pack coupling, the most notable of which makes further advancements toward the goal of infinite service life. R+W Survivor series couplings transmit torque across the disc pack assemblies purely by friction. A series of bushings are pressed together by R+W to assemble the disc packs, while precision locating features in the hubs and spacers present a concentric fit. The bolt assemblies are then tightened through the hubs, spacers and bushings to generate the necessary clamping pressure across the faces of the disc packs to transmit all of the power by friction. This purely backlash free friction fit serves to eliminate problems associated with stress concentration, backlash, and micro-movements, all of which can result from transmitting torque across the shanks of shoulder bolts. The frictional connection of the disc packs further increases service life, in addition to making the complete coupling assembly more torsionally stiff.

The first generation of LP-Survivor series couplings consists of both single and double flex versions to mount by keyway and set screw (LP1+LP2), a double flex version with precision conical clamping ring assemblies (LP3), and a special API 610 version (LPA) which meets all of the stringent requirements for critical centrifugal pumping applications. Two standard spacer lengths are available for each double flex version, with full customization of dimensions and materials available, depending on the specific application



Bellows couplings are typically used for servo drives and high precision applications.

requirements. As with all R+W couplings, the LP couplings are available with either imperial or metric bore diameters ranging from 18 to 170 mm (~¾" to 6-5/8") and with torque capacities ranging up to 20,000 N-m (177,000 in-lbs). Whatever the requirements may be, an R+W coupling expert is available to help in the sizing, selecting and customization of the ideal high performance shaft coupling for your requirements.

For more information:

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Brevini Power Transmission

OFFERS DRIVE SOLUTION FOR THEME PARK

Brevini Power Transmission has supplied a new motor and gearbox package to a theme park in the United Kingdom. The project required a compact drive arrangement to provide power to the rotating ride which could be delivered within a short lead time to suit the tight build schedule.

The Fireball ride, located at The Adventure Island Park in Southend on Sea, Essex, has provided thrills to thousands of children and adults alike. The ride, which stands 9 m tall, consists of a tower which holds a rotating hub with eight arms; each arm has a double seat attached to the end of it. It was designed and constructed by the park's own in-house engineering team, Adventure Island Workshop, who asked Brevini Power Transmission to supply the main drive unit.

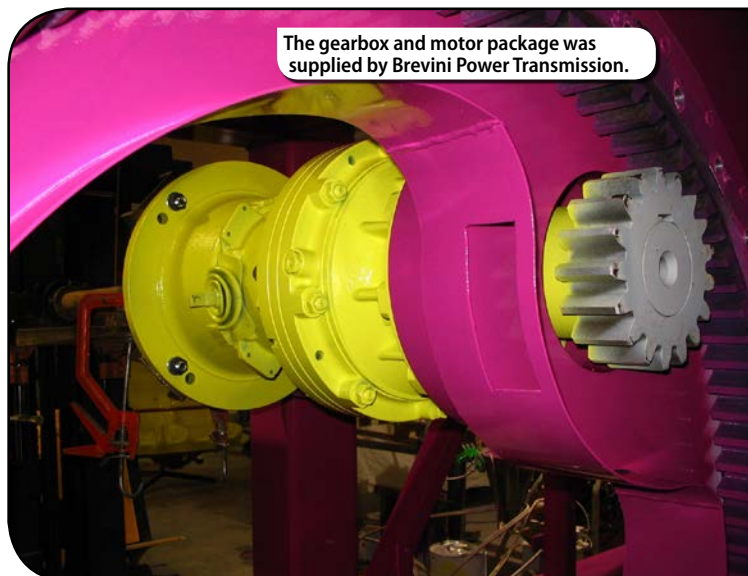
Brevini specified a High Torque S-series reduction gearbox coupled to an electric motor, which allowed the drive system to fit within the main framework of the design. In addition, Brevini was able to ensure the components were delivered on time to meet the build schedule of the ride.

The gearbox and motor arrangement is mounted directly to the main frame of the ride using the motor foot plate and the drive end flange. This design meant that the drive

assembly had to be as compact as possible while still being capable of producing the power required. The drive also had to meet the rigorous safety standards demanded on amusement park rides.

The S-series planetary range has been designed to give optimal performance with minimum size and has the ability to offer a 40–60 percent reduction in terms of size and weight against traditional gear solutions. The result is an extremely robust and yet cost effective solution. The range now spans a torque range from 1 kN-m up to 2,500 kN-m, with larger variants available on request.

S-series gearboxes can provide up to four reduction stag-



es as standard, with both in-line and right-angle versions. Additional reduction stages can easily be incorporated to achieve extremely high reduction ratios while maintaining a high overall efficiency. Output shaft options include female splined, hollow cylindrical, male cylindrical and male splined versions. The gear unit input can incorporate a multitude of different motor adaptations (electric, hydraulic, etc.); can incorporate a multidisc brake; and can of course be a simple male shaft. A wide range of input and output accessories is also available.

Brevini is also involved in the maintenance and replacement of drive systems in other theme parks, such as the Pleasure Beach in Blackpool, where it has repaired and replaced various gearboxes in many of the U.K.'s most famous rides. In each case a specialist engineer from Brevini inspected the gearbox and ascertained which should be repaired and which would be more cost effective to replace.

For more information:

Brevini Power Transmission U.K.
Phone: +(44) 1925-636682
www.brevini.co.uk



Ruland

EXPANDS RANGE OF COUPLINGS

Ruland's coupling line includes rigid couplings with precision honed bores and five types of zero-backlash couplings: beam, bellows, disc, jaw and Oldham. This complete range of options gives customers the ability to select the proper coupling based on their design parameters. Ruland has experienced sales and engineering teams with extensive application knowledge in the USA, Europe and Asia to help customers identify the best coupling solutions.

Ruland services many high tech industries including semi-



conductor, solar, medical, food, packaging, printing, labeling, linear and petrochemical. Each industry requires couplings to have different performance characteristics. Beam and Oldham couplings are good choices for applications that require higher amounts of misalignment with zero-backlash performance, while bellows, disc, and jaw couplings are ideal for applications that require high accuracy, repeatability, and zero-backlash. Rigid couplings are a good fit across many industries, provided there is no misalignment, as they are the stiffest, most accurate, and available in the widest array of sizes, styles and materials. Ruland couplings feature a balanced design that allows them to run at higher speeds with reduced vibration.

"Special couplings can be manufactured based on customer requirements if a standard offering is not suitable," explains William Hewitson, Ruland's vice president of operations. "Our engineers will work directly with customer engineering teams to build a coupling that meets specifications and minimizes cost." Prior specials include custom bore tolerances and geometries, materials for high temperature and chemical resistance, custom screw sizes for installation standardization, 303 or 316 stainless steel coupling hubs for corrosion resistance, and many others.

Couplings are part of Ruland's complete product line, which features a wide variety of shaft collars, including one- and two-piece clamp-styles, threaded, heavy duty, double wide, and keyed. Ruland has recently released quick clamping shaft collars for easy adjustment without tools, and wash-down shaft collars for food processing and other hygienic applications. More new shaft collar styles will be released in 2013 to better match customer needs.

"All products are manufactured in our Marlborough, Massachusetts factory for manufacturing flexibility, control of

proprietary processes, and to allow for a high level of service. Raw materials are sourced from specified mills to ensure the consistency, integrity and performance of the finished product," adds Hewitson.

For more information:

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Bauer Geared Motors

POWER UNDERGROUND MONORAIL

A large hospital complex can often resemble a small town in its size and complexity; many separate wards are joined by a narrow corridor system where the smooth transfer of supplies is often interrupted by busy doctors and nursing staff. One of Europe's largest hospitals has solved the problem with an automated underground monorail that supplies medicine, food and linen with minimal effort and at low cost. Bauer geared motors drive the vehicles and operate the track points.

The hospital in question, located in Southeastern Germany, now employs over 8,000 staff who work in 110 wards, providing healthcare to almost 55,000 in-patients each year. With each ward needing regular supplies, it is vital that the hospital's logistics model is as modern as its medical equipment. It is for this purpose that there is a complex network of underground tunnels under the University, one that has been developing since the 1920s.

The tunnel network was first built to allow service staff to push supply carts between wards without holding up the medical activity taking place above them; the network has continued to grow over the years and now stretches to 6.7 km in total. As the hospital has grown in size, so too has the delivery system grown in sophistication, and in 1969 a monorail system was implemented to speed up the delivery process.

The hospital regularly invests in new technology for the tunnel network. This investment has led to the automation of the monorail by one of Germany's leading transport technology experts. The automated rail system is now able to deliver meals, medicine and linen from nine dispatch stations to 101 destination stations around the hospital, making 16,000 trips per week. Labor costs are kept to an absolute minimum as the entire network is operated and maintained by a team of eight people.

With such a small team manning a system whose smooth operation can quite literally mean life or death, it is important that all the components on the vehicles and rail system offer superb reliability and long life. Geared motors from Bauer, part of Altra Industrial Motion, have been specified to drive the vehicles and operate the points.

A member of the team tasked with updating the tunnel system says: "When a problem occurs with the monorail, a supervisor has to cycle to the point of the problem to repair it; we try to make sure that these problems are as infrequent as possible. There are 140 vehicles in operation on a track with many points along the way. Some of the first Bauer drive units to be used are now nearly 40 years old and still running



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smoothly, it is very rare that they provide the team with a source of exercise, so it made sense to us to continue to specify Bauer units as the newer parts of the system were being developed."

To operate safely and efficiently, the vehicles need to accelerate smoothly to a pre-determined velocity, even when loaded with heavy supplies. Bauer's BG series of helical geared motors were used as they offer torque values of up to 18,500 N-m with high output speeds. The motors can be easily integrated with an inverter to ensure that the acceleration curve is constant in every journey. The gears are designed with ingress protection of up to IP66 and lubricant changes are only required after 15,000 operating hours, which is ideal for an application located underground.

At various stages throughout the rail network, the points are driven by Bauer BF shaft-mounted geared motors, BK bevel geared motors and BS worm geared motors for lower speed applications requiring higher torque values.



For more information:

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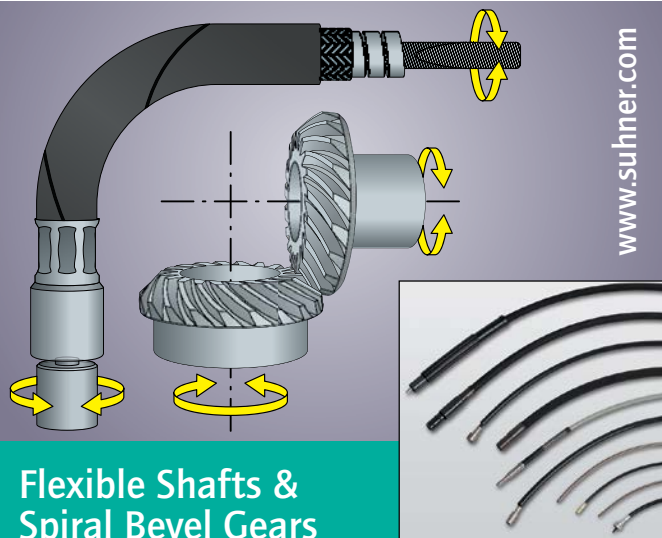
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Rexnord

INTRODUCES THOMAS XTSR DISC COUPLINGS

Rexnord recently introduced its new Thomas XTSR52 and XTSR71 Disc Couplings. "Committed to evolving with customers and their needs, Rexnord has advanced the Thomas Series 52 and 71 with the launch of the Thomas XTSR Disc Coupling offering," explains Santanu Debnath, director, commercial operations, coupling. The Thomas XTSR Disc Couplings are used by rotating equipment engineers in industries such as oil and gas, petrochemical and power generation.

Combining compact size and powerful performance, the Thomas XTSR52 and XTSR71 provide customers with:

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Voith Turbo

DELIVERS FLUID COUPLINGS IN MALAYSIA

Voith recently delivered 36 fluid couplings for an iron ore distribution center in Malaysia. Starting in 2014, the couplings will be used in the drives of 16 belt conveyors supplied by the Beumer Group. The supplied Voith hydrodynamic fluid couplings are ap-

plied to drives ranging in powers from 200 to 800 kW. They have been selected to softly start and protect all conveyor system components and minimize unplanned system downtime. Voith fluid couplings have a rugged design and are well suited for use under the

most extreme environmental conditions. They dampen torsional vibrations in the driveline and protect it against overload. This extends the lifetime of the entire system.

The belt conveyor drives are equipped with TVVS-type couplings. Voith is delivering special TVVS designs to match the start-up and operating conditions of the drives.



The TVVS constant-filled fluid coupling is particularly suited for medium and long belt conveyors with start-up times up to 45 seconds. Fluid couplings automatically match the demand torque of the driven conveyor. The smooth application of fluid coupling torque provides a smooth belt start-up to protect the belt from damaging stresses, thus reducing system downtimes.

Thanks to the mechanical separation of the motor and machine through the fluid coupling, the motor can run up to speed without load. In addition, systems that use multiple motors can be switched on in a staggered sequence to limit the current demanded during the motor acceleration. This avoids grid overloading caused by simultaneous motor starts. In the most demanding belt conveyors, the TVVS is deployed with centrifugal force valves to further protect the electric grid. Centrifugal valves control the filling and draining of the coupling working circuit, and thus the power transmission, as a function of the drive speed. The motor starts up virtually load-free, even in the event of voltage drops. The coupling torque is applied continuously and without shocks up to the required breakaway torque of the system.

The TVVS can also use water as the operating medium. This environmentally-friendly operating medium is particularly well-suited for use in the belt conveyors that transport iron ore above the ocean.

In the future, the Malaysian iron ore distribution center will supply customers in the Asian-Pacific region with iron ore from South America. The belt conveyors transport the iron ore from the terminal to the harbor.

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Randy Stott, Managing Editor

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It's quiet out there

Brian Langenberg, CFA

Since our last appearance in this space we've attended the Paris Air Show and met with companies involved in oil production, hydraulic fracturing and wind turbine towers and components. As an investment analyst I am always seeking to help my clients anticipate change in order to manage risk and capture alpha (positive returns relative to market). But as a regular columnist for *Power Transmission Engineering*, I also seek insights that can help your organization do the same. Here is what we've found:

Little has changed in the actual economy since our last article. Second quarter revenue and earnings are indicating a sluggish global industrial economy — but also pockets of growth and, we believe, one that should modestly accelerate both sequentially and against easy prior year comparisons in the second half.

Optimism persists—in certain sectors. Energy and commercial aviation demand continues to grow; both are justified. Energy is a strategic imperative for any growing, or mature, economy. Commercial aviation investment is being enabled by better cash flow and is necessitated by the need to migrate to more efficient aircraft fleets. General Electric and United Technologies continue to spend heavily on engineering to get those new engines ready.

Easier comparisons will help elsewhere. We expect improving year/year results in the second half in construction equipment and truck engines—particularly in North America.

Mining can't be helped. It is rolling over. Expect good consumables activity, but new equipment and projects will taper off; figure down (20–30 percent) over the next 2–3 years.

Overall, we remain in a moderate, global economic growth environment that should continue to support maintenance capital spending and selected expansion, but no significant increases. For detail, eight of the ten industry verticals in our broader GIO are detailed below:

Oil & Gas: Rig count growth globally will continue (upstream), while North America starts to see easier comparisons. We've met with the C suite of two upstream companies this month and activity remains strong. Offshore production remains hot, as upstream is a strategic imperative for developing nations; key beneficiaries include GE, Siemens and Dover Corporation. Closer to home, North American mid-stream activity (pipelines and infrastructure) remains robust and it is possible, though too early to tell, if the oil train tragedy in Quebec can spur less resistance to pipeline building.

Mining: In our view, capital spending is likely to decline by (20–30 percent) over the next 2–3 years, and this is incrementally negative for Caterpillar, Joy Global and Atlas Copco. Large miners will likely complete current projects but their “unapproved” projects smell like vapor to us. The challenge now is driving productivity, not spending more. And many small mining companies are broke. Not good.

Power generation: U.S. demand will not pick up before 2015–2016, as greater energy efficiency and modest economic growth keep reserve margins (excess generation capacity) sufficiently high to push out investment. While arguments abound that aging plants must close and a “war on coal” might force increased investment, we are highly skeptical the current administration has the muscle to force the issue. Wind comparisons will get better after year end, but we are not holding our breath on a return of the production tax credit (PTC). And even if it happened, we anticipate a more steady pace of activity once those comparisons are worked through. Globally, capacity additions are strong in Asia (Chinese coal in particular) and should continue, while a number of projects are working their way into backlog with E&C companies.

Transportation infrastructure: Off-shore-related activity remains strong and we've heard rumors of a pick-up in

shipping that we do not believe (well, perhaps a bump off the bottom), except for specialized needs like LNG (liquefied natural gas). Road construction and repair work will be steady—at least through 2014—owing to the two-year highway bill extension, and should be supportive of steel and cement demand at or near current levels. Sequestration matters, however.

Water & Environmental: Municipal budgets remain strained and industrial customers choose not to invest, though we note that easier comparisons are coming in the second half. Internationally we are hearing of strong, continued demand—particularly in desalination. The North American outlook should improve, on a lagging basis, with rising home prices driving higher priority taxes. Notably, a private E&C executive recently told us he is actively seeking to hire sales engineers to support opportunities in the U.S. and Mexico.

Machinery: Overall picture continues to improve.

Construction equipment production is now rising sequentially, as Caterpillar has worked off excess inventory, and second-half comparisons will be easy. Much controversy is arising from China, given weak exports (though we don't believe the recent “down 3 percent”; that smells like better accounting on invoices). **Mining equipment** is another matter, and layoffs in Milwaukee do not strike us as being likely to reverse. Tough financial conditions with Canadian junior miners could lead to excess equipment coming on market. **Truck engines** are set to recover. **Agricultural equipment** demand in North America is expected to soften year/year through Deere's fiscal year ending October 31st, in what is best described as a “more of same” environment (high farmer cash receipts, steady demand).

Consumer (auto, appliances): In the U.S., improving real estate prices are helping bolster consumer balance sheets and thus pent up demand for durable goods. Nothing dramatic, but

figure > 5-10 percent for appliances and, more importantly for you and the U.S. economy, continued strength in auto production. Internationally, Europe remains weak, though easier comparisons are coming, and certain resource-rich emerging markets (Middle East, Africa) will also show continued growth.

Aerospace/Defense: A couple of moving parts here. Commercial activity remains robust, while sequestration is now sinking its teeth into operating tempo. On the commercial side, at the Paris Air show and in our discussions with multiple executives, continued optimism was backed up by solid order books. Pockets of weakness do persist—lowered air freight demand is a negative—but will be more than offset by airline requirements for more efficient aircraft. Aftermarket MRO remains weak, although components specific to power transmission should do relatively well. General Electric and United Technologies (Pratt & Whitney) continue to invest to grow their new-generation engine offerings to support customer demand. The competitive game is on: UTX is getting back into commercial aircraft engines through its wins with Bombardier (BBD.B) and Embraer (ERJ); General Electric must keep up. Defense is another matter. Sequestration is also taking a bite out of U.S. operating tempo, and international sales are not going to completely pick up the slack. Do not confuse yourself with the idea that long-term thinking will prevail; the F-35 is actually at risk of a delay that will drive higher long-term costs, and even if it doesn't happen, we know of civilian DoD employees that are on 32-hour weeks.

Capital spending: flat at best—no better. Deals create risk for you. The global economy continues to grow, but not fast enough to drive significant growth in global fixed investment. Generally speaking, the C-suites are focused on optimizing footprint, improving supply chain and driving productivity. There is no time like the present

to think very hard about business risk. The urge to merge is high—and usually leads to delayed or cancelled capital spending at the target. If a single client or factory generates more than 10 percent of your sales, we should talk. We can help you assess your risk and develop a growth strategy to protect your company.

Focus company: Caterpillar (CAT). We chose Caterpillar because it is leveraged to nearly every industry vertical we track: Oil & Gas, Mining, Power Generation, Infrastructure—you name it. After an ambitious capital spending and growth strategy coming out of the downturn, Caterpillar hit a wall in mid-2012 as overproduction of excavators, particularly in China, came home to roost and since then has been exacerbated by weakness in stationary power and now the mining downturn. The company reports three primary segments: Construction, Resources, and Power Systems. But given the audience, we are going to focus on North America as a region.

North American revenue declined (21 percent) in the first quarter and a negative 2Q comparison will be reported by the time this article is published. Power Systems is about 40 percent of current North American revenue and is working through a weak hydraulic fracturing market. After 2Q there will be one more negative comparison, and

recent discussions with field contacts suggest the excess equipment in the shale regions has been worked down. Construction (33 percent) is already improving sequentially and comparisons turn positive no later than 4Q. As for resources, mining is, and will remain, very ugly. Aftermarket demand turned negative in the September 2012 quarter, and new equipment revenue followed in 1Q13, and we see continued weakness—possibly worsening—for at least the next year. Continued capacity utilization should at least start to support aftermarket.

Overall, we expect management will maintain a measured approach to capital investment at this point. Global Industrial Outlook: Meh—For Now. **PTE**

Brian K. Langenberg, CFA,

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



Shaking Hands in Indianapolis

Manufacturers Set to Talk with Buyers at Gear Expo

Matthew Jaster, Senior Editor

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The inbox is obnoxious. This magazine is guilty. You're guilty. We're all guilty of spending a little too much time at the keyboard, iPad or smart phone checking mail, sending mail and deciphering text messages from our sons and daughters. I'm worried that our collective thumbs are going to fall off sometime before 2015.

Fortunately, we haven't forgotten what it's like to hold an *actual conversation* with another human being. The upcoming Gear Expo, taking place in Indianapolis from September 17–19, gives the gear industry an opportunity to convene in one location and talk shop face to face. This is extremely valuable in 2013 when surfing, sharing, linking, tweeting and posting is nice and everything—but isn't nearly enough.

There were approximately 50 gear manufacturers that participated in the 2011 Gear Expo held in Cincinnati, Ohio. This number is closer to 75 (so far) for the 2013 show in Indianapolis.

"We have a strong number of gear manufacturers that will be there to talk with gear buyers. The interest level in Gear Expo continues to increase," says Jenny Blackford, AGMA director of marketing and communication. "I'm happy to report that the 2013 show will be 20 percent larger than the show in Cincinnati."



N.K. "Chinn" Chinnusamy explains his products during a previous Gear Expo show.

"We want these customers to become aware of the fact that we're a full service manufacturer, in addition to our gear making capabilities."

JAMES MANNING, STD Precision Gear

Indianapolis To-Do-List

So why should you attend Gear Expo if you're in the business of buying gears? First, it's rare to find so many gear manufacturers under one roof. This show provides a unique opportunity to discuss capabilities, technological developments and future markets for gears and geared products. Instead of communicating via phone or e-mail, gear buyers can discuss the complex components they need with some of the engineers that make them. It's not unheard of to find a couple of engineers tucked away in a corner of a booth trying to resolve a manufacturing challenge onsite.

"As in years past, our goals for the show are to meet new potential customers, inform them of our areas of expertise, and find ways to integrate our



Arrow Gear has a long history of producing high precision gearing for aerospace systems.

expertise with their business needs," says Joe Arvin, president and COO of Arrow Gear.

"We're planning to meet with existing and candidate customers and suppliers," says Tony Miller, vice president of sales and marketing at Fabco Automotive Corp. "Loose gear alternatives to improve cost and lead time will be discussed during the show."

"We hope to access the spiral bevel gear market in the United States," says

Vincent Chen, sales executive at Yager Gear Enterprise Co., Ltd. "We would like to have an opportunity to discuss the present as well as potential business in this market during Gear Expo."

James Manning, president at STD Precision Gear and Instrument, hopes to gain recognition and RFQs from potential customers for the complex geometry work the company produces. "We want these customers to become

aware of the fact that we're a full service manufacturer, in addition to our gear making capabilities. We are Nad-cap accredited for heat treating (PH Stainless Alloys) and chemical processing (passivation) adding depth to our capabilities as well as our quality management system."

"As with any exhibitor, we hope to get more exposure and awareness to our company and potentially find new

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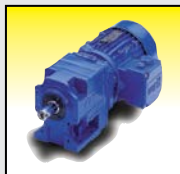
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opportunities to support our business," says Mike Goza, general manager at First Gear Engineering and Technology.

Tony Werschky, sales manager and partner for the Delta family of companies (Delta Gear, Delta Research and Delta Inspection) would like to build better brand awareness to leaders in the industry and to engineers and buyers during

Gear Expo. "We'd also like to maintain the relationships we currently have not only with our customers but our suppliers and look to develop at least one large new relationship with a prospective customer," Werschky says.

The Exhibit Hall

The 2013 show at the Indiana Convention Center will look nothing like the Gear Expo that took place in this building in 2009. AGMA is utilizing a new section of the convention center and the layout has changed. "The move brings us a little closer to the restaurant and entertainment district, AGMA's Blackford says. Those that attended the



Delta Gear has been making master gears, spline gears, aerospace gears and automotive prototype gears since 1964.

2009 show in Indianapolis will have an entirely new experience in 2013."

Blackford adds that the entire gear manufacturing process will be well represented on the show floor. "It follows the gamut of operations you'll find in the gear industry, everything from forging to inspection to heat treat. Plus, there's an increased presence for gear manufacturers."

These gear manufacturers will be displaying a wide variety of new products/technologies and focus on educating the entire industry.

"This year, Arrow Gear will feature an interactive virtual tour which will be displayed on a large TV monitor. Visitors to the booth will be able to control the navigation of the virtual tour to explore 360-degree panoramic images of all the major areas of our plant. In addition, the virtual tour will also feature numerous videos on points of interest," Arvin says. "We feel this tool will provide a comprehensive overview of the extensive level of technology available from Arrow. It should also be noted that the virtual tour is available through Arrow's website and we will be using this to serve as a learning platform for young people who are contemplating careers in high precision manufacturing. To accomplish this we are promoting the virtual tour to middle schools, high schools, junior colleges as well as other organizations in an effort to engage a wide range of career counselors, educators, students, and their parents."



Photo courtesy of Delta Gear.

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Wednesday 9:00 am–5:00 pm

Thursday 9:00 am–4:00 pm

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Gear Expo 2013 Schedule

Saturday, September 14

Registration Open 10:00 am – 5:00 pm

Sunday, September 15

Fall Technical Meeting 7:00 am – 5:00 pm

Registration Open 7:00 am – 5:00 pm

Monday, September 16

Fall Technical Meeting 7:00 am – 5:00 pm

Registration Open 7:30 am – 6:00 pm

Tuesday, September 17

Fall Technical Meeting 7:00 am – 5:00 pm

Registration Open 7:30 am – 6:00 pm

Training School for Gear Manufacturing
8:00 am – 12 noon

Where Do I Start? The Preliminary Gear Design Thought Process 8:00 am – 4:00 pm

Exhibit Hall Open 9:00 am – 6:00 pm

Why Bearings Fail 1:00 pm – 5:00 pm

Networking Reception 5:00 pm – 6:00 pm

Wednesday, September 18

Registration Open 7:30 am – 5:00 pm

How to Organize and Manage a Failure Investigation 8:00 am – 4:00 pm

Exhibit Hall Open 9:00 am – 5:00 pm

Thursday, September 19

Registration Open 7:30 am – 4:00 pm

Inspection Criteria for Gearboxes 8:00 am – 4:00 pm

Materials Selection and Heat Treatment of Gears 8:00 am – 4:30 pm

Exhibit Hall Open 9:00 am – 4:00 pm



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“Our goals for the show are to meet new potential customers, inform them of our areas of expertise and find ways to integrate our expertise with their business needs.”

JOE ARVIN, Arrow Gear

“We will be displaying examples of the work we have manufactured over the years,” says Manning from STD Precision. “Very complex geometry with tight tolerances that is both very interesting and diverse. We also want to get the word out that we are in the process of setting up a liquid salt bath Ferritic Nitrocarburizing line to meet the requirements of AMS 27533 and that we intend to apply to PRI for a Nadcap process audit.”

“Our sister company Delta Inspection is a contract inspection company with a main focus on gear metrology,” says Delta’s Werschky. “It is a 17025 accredited gear inspection lab through

A2LA. We will be presenting its capabilities and talking to customers about how Delta Inspection can help them with engineering development, part sorting, quality control and consulting services. In addition to Delta Inspection, our other sister company, Realtrac, will be launching a new job tracking software available for sale to the public which is ideal for gear and heat treatment. Realtrac, who is a veteran in Enterprise Resource Planning and Job-Tracking software industry for over 25 years. Known as “the Easy Resource Planning” software, it is very simple and intuitive and yet still a very powerful, in-depth planning software.

Anyone who stops by our booth can enter a daily drawing for free iPad.”

The Yager Gear Enterprise booth will showcase the spiral bevel gear work the company provides for electric and pneumatic tools, machine tools, agricultural machinery and automobiles. “At Gear Expo, we’ll show the spiral bevel gear with the technology of CNC and lapping from small to big module,” says Chen.

First Gear Engineering and Technology hopes to get more exposure during Gear Expo and find new opportunities to grow. “We will basically feature a video of our CNC hobbing and shaping operations,” says Goza. “First Gear representatives will be available at our booth to discuss our gear manufacturing capabilities and the services we can provide our customers.”

Education and New Technology

One way AGMA is increasing trade show attendance is to bring more new and mid-level employees into the mix



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by offering comprehensive training and educational sessions. AGMA's Blackford credits increased interest in Gear Expo to the organization's push to create more educational opportunities at the show. This means a full slate of sessions during the Fall Technical Meeting and a diverse lineup for the Solution Center during Gear Expo.

Many exhibitors, including Arrow and Delta, see the advantages of Gear Expo from an educational standpoint.

"Several of our new engineers will be attending Gear Expo this year for the first time. We feel this is crucial to building their experience and adding to their knowledge base. Having face-to-face discussion with others in the gear industry and those who provide services we may use is highly valuable as it leads to a broader appreciation for the industry as a whole," Arvin says. "I would have to say that industry trends are always at the forefront of people's minds during events like Gear Expo. Learning about areas that are healthy and those that are not are critical to competitive planning. Second only to industry trends is the issue of new technology. Remaining competitive in the gear industry requires that we carefully assess any new technology as soon as it is available," Arvin says.

"It's important to educate yourself in the latest technologies and look for ways to differentiate yourself from your competition," Werschky says. He adds that Gear Expo will provide a great opportunity to engage in discussions on isotropic superfinishing (ISF) and its effect on the overall performance of gears.

"I think there will be discussion regarding the future gearboxes of the auto industry with relation to multi-speed electric car transmission vs. highly engineered electric motors. Also, companies like Gleason and Ionbond continue to come out with new specialty coatings for the tool industry which offer significant cost saving opportunities for our high volume production gear cells," Werschky adds. "I am interested in learning more about these new technologies and which coatings work best with the materials that we are machining."

Crunching Numbers

A highlight of Gear Expo is the economic forecast keynote that takes place on Tuesday, September 17th. *Gear Technology* decided to get a head start on the economic discussion by asking a few of the gear manufacturers to report conditions today and what they believe it will look like in the near future.

"Companies associated with the auto industry are much more excited about

what lies ahead. This is partially due to a few things. According to the Polk Research, the current age of automobile and truck fleets are on average 11 years old and car makers are struggling to increase production, dealers and their overall network to keep up with the renewed demand from the crash of 2009. And although demand is still sluggish for electric vehicles, there is a steady growth in popularity towards hybrid vehicles where you can provide fuel

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economy without excluding performance,” says Werschky at Delta. “Development of more fuel efficient transmissions has given rise to opportunity in the automotive gear business. This may start to wean a little as many of these newly developed transmissions will soon go into production.”

There have been mixed results for the launch of the Boeing 787 in the aerospace industry, he adds.

“This fly-by-wire aircraft’s reputation has been damaged by production delays, temporary groundings and FAA warnings. Additionally, Boeing and their OEM supply base produced roughly 30 percent of the aircraft overseas, which has helped cause the delays and quality concerns. What we have seen at our Delta Gear facility where we make predominantly aerospace gears is that some of this work is returning back to the states. Unfortu-

nately, the OEMs want the pricing they received in the third world economy with the quality that they are accustomed to receiving here in the states. We should continue to see the aerospace gear market continue to stay steady for now,” Werschky says.

“There is the ever-increasing demand for meeting rigid specifications while keeping prices low,” adds Arvin at Arrow Gear. “Arrow has met this challenge through an aggressive focus on productivity, process improvement, and the latest technologies. Arrow’s sales have increased nearly 30 percent in the last year and we are anxious to communicate to the industry how we are keeping pace with the leading edge of gear manufacturing.”

Others exhibiting at the Expo have mixed feelings for the economic forecast.

“We expect an increase in the automotive sector but a decrease in our aerospace business,” adds Albers at Euro-Tech.

“Our business to date has been fairly strong, exceeding sales thru the same period in 2012. It’s anyone’s guess but hopefully there will be continued improvement in the economy and the result will mean increased business opportunities in 2014 for the overall gear industry,” Goza says.

“Our business is strong so far in 2013,” says Manning at STD Precision. “I am cautiously optimistic about expectations for 2014.”

“Business in 2013 is similar to 2012,” says Chen at Yager Gear. “We expect that the business is going to increase 10 to 15 percent in 2014.”

“Related to the overall market, our outlook for the next year is for flat growth due to a trickle down reaction to new higher-tax legislation implemented in 2013 that most of which we will start to see its effects on the economy by the beginning of 2014,” Werschky adds.

How About a Handshake and a Smile?

The average gear engineer can find plenty of relevant activity at various trade shows (see CIMT, EMO Hannover and IMTS). At most of these ex-



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hibitions, however, you'll find pockets of exhibitors and/or attendees that play a role in the gear industry. You'll also find exhibitors, educational sessions and keynote addresses that have little or nothing to do with your business. Frequently, it's more about cutting through the fat and searching for the exhibitors and programs relevant to your business.

Gear Expo is the gear industry. It boasts the companies involved in every aspect of the designing, manufacturing and selling gear and geared products.

"Obviously, for those of us who have been with Gear Expo from the start, are keenly aware of how participation has increased from year to year. Having an increasing presence by suppliers to the gear industry further enhances the experience," Arvin says.

While an added social media presence will be welcome at Gear Expo 2013 (AGMA is debuting the official Gear Expo App and monitors displaying social media updates will be featured throughout the show), it really comes back to the handshakes in Indianapolis.

"It's an opportunity to meet old friends. You meet some great people during Gear Expo and you come back to the next show and recognize all these faces," says Charlie Fischer, AGMA vice president/technical division. "It's a great way to establish a lifelong bond with your peers in the industry."

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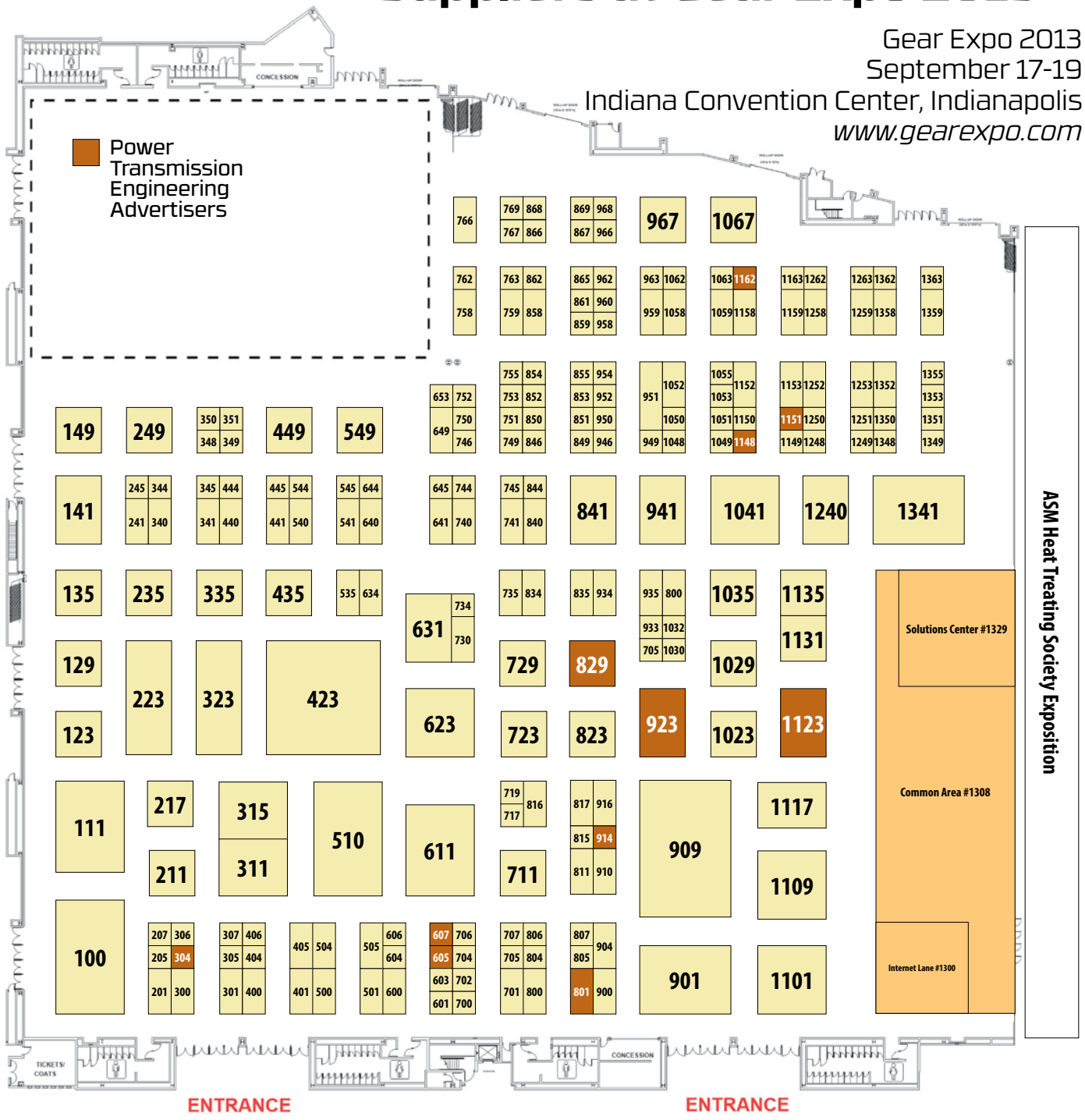
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Medical Motion Control

Quicksilver and VibeTech Collaborate on Therapy System

Donald Labriola, Quicksilver Controls
Jeff Leismer, Vibetech, Inc.

The lack of gravity in space reduces the mechanical loading seen by both the muscles and bones of the body, especially those related to standing and moving. The body adapts to reduced loading by losing bone mass and muscle mass. In long-duration space flights this leads to “disuse atrophy,” which requires rehabilitation

designed by Dr. Jeff Leismer, to enable longer space flights by reducing atrophy. The therapy is now being used to help terrestrial patients with impaired mobility to regain strength and function.

A similar bone loss and muscle loss occurs on Earth for those with reduced mobility due to injury, surgery, hospitalization and the aging process.

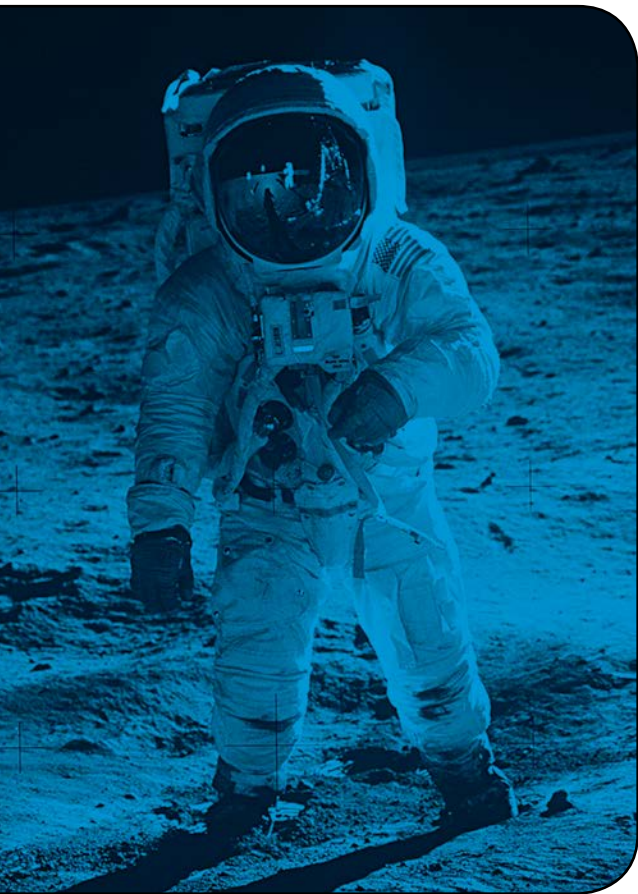
Just as in space, the lack of sufficient loading of the muscles and strains on the bones signals the body to match the capability with the need — and bone loss along with muscle loss occurs. The result is that many patients suffering from disuse atrophy do not have the balance or strength to perform weight bearing physical activity, making conventional physical therapy difficult. Thus a new therapy modality was developed to mimic biomechanical loading acting on the region of the body most affected by disuse — the lower extremities — without requiring any effort on part of the patient. Studies that have applied similar vibration to standing users have shown that the treatment can help restore both muscle mass and bone density, and further help improve coordination and neural sensation by stimulation

of the nerves. The desired outcome of the passive form of vibration therapy is to improve strength, mobility and balance in patients for whom standing is difficult or impossible, thus resulting in improved independence, quality



of life and health outlook for the patient. Other vibration studies involving animals indicate that the therapy can also help speed the healing of broken bones, which could be especially important for healing hip fractures as well as reducing the associated atrophy and functional decline that is so detrimental to hip fracture patients.

This therapy relies on the alignment of an adjustable compressive force with a precisely controlled vibration along the axis of the tissue to be treated. The compressive force preloads the tissues to be stimulated and allows effective vibration transmission from the foot, through the lower extremities and into the lower back. This pathway simulates vibrations that are transmitted through the legs due to foot impact with the ground during walking. The force/vibration may be applied and aligned to target different treatment areas with appropriate intensity and



Technology to prevent muscle and bone atrophy for astronauts is now being brought to people experiencing disuse atrophy on Earth (courtesy of NASA).

once the astronauts return to earth. An astronaut may lose as much as 20 percent of his bone mass in a single year in space. A countermeasure therapy using passive vibration for neuromusculoskeletal stimulation was originally

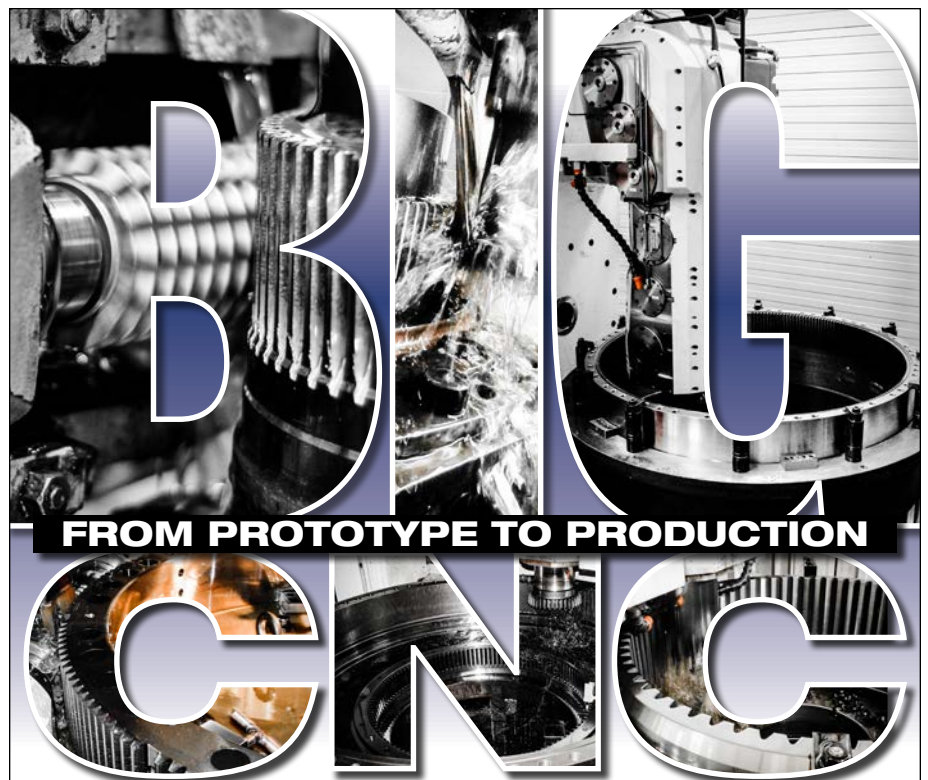


frequency profiles. Standing methods for vibration therapy that use gravity as the force component not only require balance and strength to receive treatment, but also apply the vibration to the “whole body,” which necessarily requires a compromise to protect the more fragile tissues.

The physics behind the treatment involves applying controlled stresses to the bones, resulting in minute tissue deflections (strains). Bone cells detect these controlled strains and direct the body to increase bone density in the portions of the bone experiencing these deflections. For bones with weakened areas, larger deflections will occur in those areas, thus signaling the bone to adapt — add density — right where it is needed. In the case of a healing fracture, this same process again helps direct repair mechanisms at the fracture site, speeding healing. This challenging of the bone to adapt and strengthen is especially important while the bone is still healing and will not support the weight of a patient standing.

The physiology related to improving muscle strength and nerve response with vibration therapy is based on using frequencies and amplitudes which stimulate the body’s stretch reflexes. Correctly applied vibrations engage reflexive muscle contractions — exercis-

ing the muscle to reduce atrophy and restore neuromuscular coordination. This process also stimulates nerves which may have been compromised. This later effect may be useful in the development of proper treatment protocols for neuropathy — nerve damage resulting from diabetes as well as other diseases. Improving strength and neural sensation in the legs could also help reduce the risk of falling.



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The engineering and motion control challenges include the need to provide repeatable and programmable partial bodyweight loading through the lower extremities while generating precise, adjustable vibration dosing targeted at key muscle groups throughout the lower extremities and lower back. The vibratory source needs to be programmable both in amplitude and in frequency to account for the wide spectrum of patients who can be treated by the system (ranging from comatose

The VibeTech technology uses Quicksilver Controls' SilverSterling controllers to closely mimic the natural biomechanical loading of weight-bearing physical activity (courtesy of VibeTech).



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patients and those with significantly reduced lower extremity function to elite athletes who are recovering from sports injuries). The motion control needs to be consistent over a wide range of partial body weight load levels and of patient tissue properties. The stimulation requires the power capability needed to adequately provide stimulation. Finally, the noise level must be kept low for the patient.

For the first time, VibeTech, Inc. has made gravity-independent, effort-free rehabilitative vibration therapy available to people on Earth. The VibeTech One provides reactive loading through a Quicksilver Controls QCI-S2-IG that controls a loading mechanism in real time through closed-loop feedback of applied force. Precisely controlled vibrations are generated by a BEI-Kimco voice coil actuator using a Quicksilver Controls QCI-S3-IG controller and closed-loop feedback from a high resolution position sensor. The motion of both actuators is directed by the therapist by means of an HMI. **PTE**

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Flexible Options with Flexible Shafts

Guido Broder and Michael Boehm

You need to transmit a rotary motion where no straight line is possible. Or, you need to allow for some uncontrollable misalignment. How about transmission taking place between moving components? What if you need to control something in hazardous locations where you cannot directly handle the application, such as high-temperature environ-

ments, under hazardous conditions or in clean room applications? Functionally designed flexible shafts can meet all these challenges (Fig. 1).

A flexible shaft is a very effective and cost-efficient way to transmit rotary motion, power or torque. Flexible shafts are made with wire spiraled tightly around a central wire. With each layer you increase the diameter

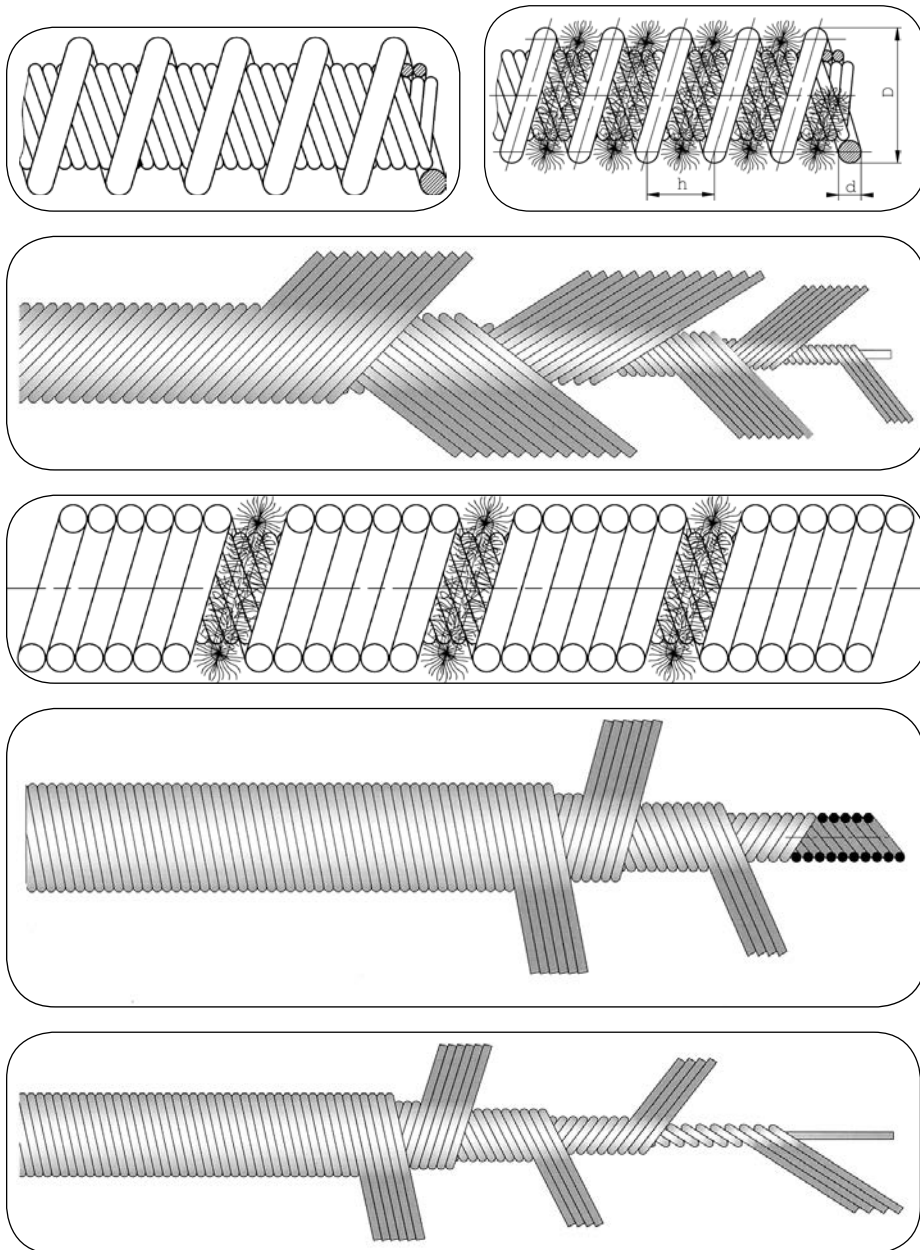


Figure 2 Different applications require different types of flexible cable.



Figure 1 Flexible cables allow design freedoms that other solutions can't match.

of the shaft and with that the torque it can transmit. Compared to a pull cable or a wire rope, where a bundle of wires is twisted together, the flexible shaft is designed and made to transmit rotary power. Layers of wire spirals are wound in opposite directions to each other and will not twist open if turned (as a wire rope would do).

Though it sounds like a very simple element, different applications require different designs, number of layers, number of wires, diameter and so on.

In flexible shaft design, it is important to know how much torque has to be transmitted, how small the minimum radius for the shaft has to be, what RPM is required, the environment the flexible shaft will work in and the preferred turning direction. Length is not critically important for the torque but plays a role in torsional deflection and has to be considered accordingly.

In flexible shaft design, unfortunately not all parameters can be stretched in all directions. For example, if more torque is required, the minimum radius goes down and with it the flexibility of the shaft. If the minimum radius can be reduced, the torsional deflection will go up, which for remote control cable is not a good thing.

Related to this basic "reality" of flexible shafts, two main design groups

emerge. First there are torque-transmission shafts, mainly for higher speed, continuous speed, pure torque transmission applications like speedometer cable or shafts for drilling applications. Second are the torsion-stable flexible shafts for mechanically remote applications, with low speed and focus on low torsional deflection. An example is slide adjustments for stationary cutting machines. Also, there are special cables like flocked shafts, hollow shafts, shafts with helix wire and so on. Figure 1 shows some examples of special flexible shafts.

Direct influences on flexible shaft specifications are: the number of layers; the number of wires-per-layer; the diameter of the wire; the wire material (with higher or lesser carbon; different tensile strengths; different plating); and the manufacturing process (settings on the winding machines).

Considering influences related to shaft manufacturing processes, it has to be understood that winding is a high-speed process where gap settings will influence the flexibility of the shaft. The winding speed and the gaps must be uniform and controlled. Gap settings are a key parameter, but not the only one. There are others, like the tension of the wire, the quality of the spooled-wire package, the temperature of the operation and so on. Experienced producers effectively control their processes and assure highest quality flexible shafts, which in turn assures successful application.

Flexible Shaft Selection

The application will for the most part determine the design of the flexible shaft. First, consider the torque (or power) that needs to be transmitted; then the routing (defining minimum bending radius); the RPM (speed required); the torsional deflection (angle of deflection under load); and the environment.

Figure 3 shows the relationship of shaft diameter to what is roughly required to transmit a certain power (kW) under a given RPM.

As an example, for a 15 mm flexible shaft, you should consider 5 kW and 2,000 RPM. The chart assumes nearly

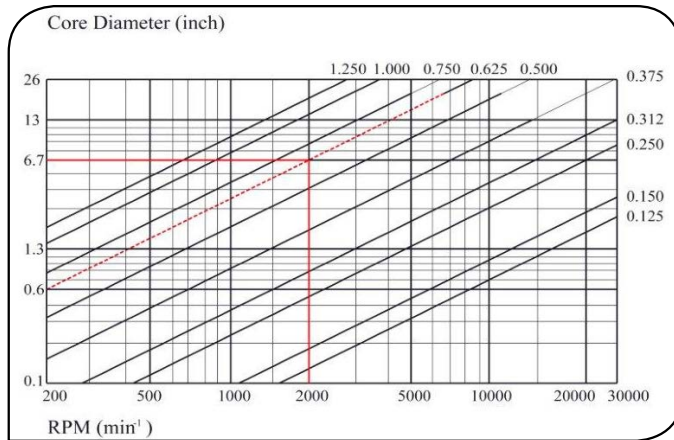


Figure 3 Power and speed depend on the flexible shaft's diameter.

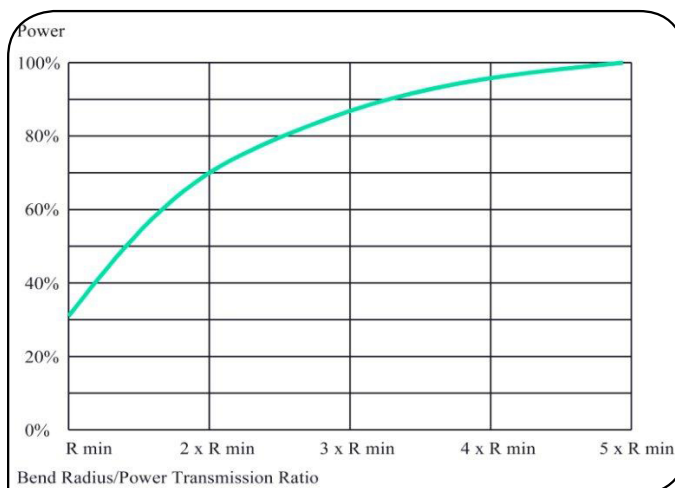


Figure 4 The amount of transmittable power depends on the bend radius.

straight conditions. The routing of the power transmission will determine the smallest radius of the system, and with that the friction or the loss of the system. A given flexible shaft has a minimum bending radius; below the minimum indicates permanent deformation (destruction) of the flexible shaft. A 3 mm shaft has a minimum bending radius of 80 mm; a 5 mm shaft 150 mm; a 7 mm shaft 210 mm; 10 mm is 300 mm; and 15 mm is 450 mm. If a system runs under minimum bending conditions, only 30 percent of the power will be transmitted; the rest is friction loss in the system radiated by heat (Fig. 4). This needs to be considered when choosing the diameter of the flexible shaft.

The degree of torsional deflection in a flexible shaft varies proportionally with the torque as well (Fig. 5). To keep the deflection and the load as low as possible, the flexible shaft should be operated at the highest possible speed

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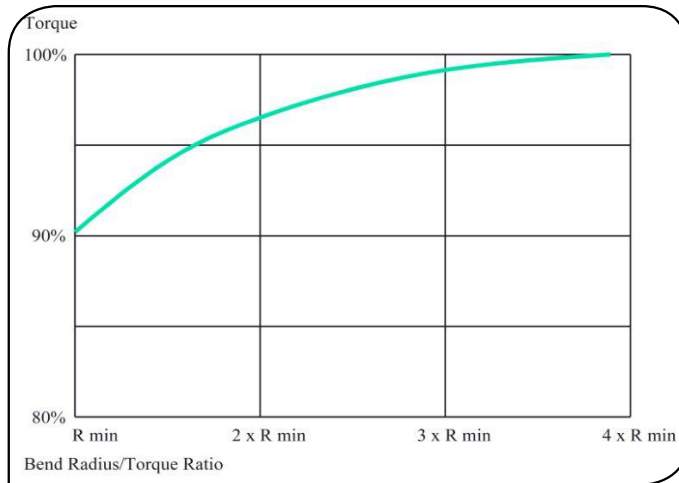


Figure 5 The degree of torsional deflection varies proportionally with the torque.

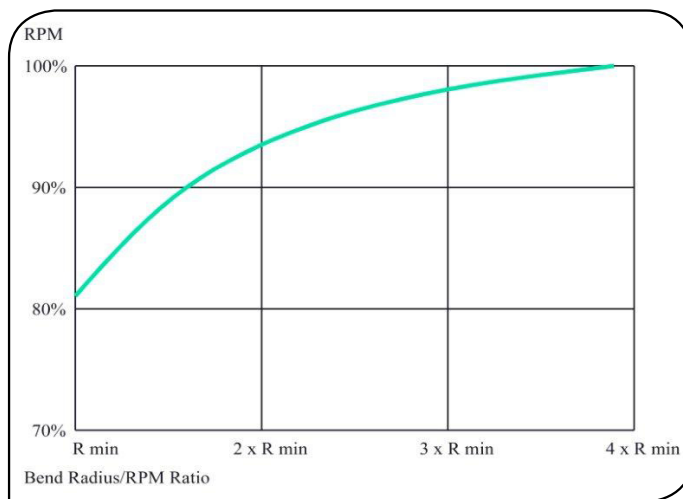


Figure 6 Higher speeds result in lower deflection and lower loads.

(Fig. 6). If needed, gear systems can also be added. Attention must also be paid to the environment in which the flexible shaft will be used. Examples include extremely high or low temperatures, moisture, corrosive influences, dust, magnetic fields, vibrations, etc. Environmental factors influence the choice of the material for the core and casing and their fabrication. The usage of brass-coated wires allows a nearly corrosion-free flexible shaft. Other effective materials are stainless steel or plastic-covered shafts (for convertible car top folding or head lamp mechanisms on some modern cars).

By knowing torque and RPM requirements and minimum bending radius, you can roughly check if a flexible shaft will suit your needs. As previously noted, there are many other parameters in flexible shaft design and manu-

facturing that influence the specification and performance of the shaft. It is possible to have a 3.2 mm speedometer shaft designed in two different ways to achieve double flexibility and therefore a smoother running shaft. This can reduce the diameter, and with that the material consumption and weight. An experienced design and manufacturing partner can help you optimize flexible shafts for price, performance, weight and other criteria.

Examples: Automotive

Flexible shafts have a growing and compelling future in the automotive industry. Ongoing competitive challenges push suppliers to develop innovative and ever-more functional and efficient solutions.

As important as changes in physical performance and outer design and

style, automobiles also need equal or better interior improvements in function and comfort. Seat adjustments and other features controlled from the dashboard have made big contributions to the feel-good factor for new car owners. Flexible shafts are small, durable and extremely effective at transmitting rotary power from a small motor (where it needs to be) to where the motion is needed.

Reliable and inexpensive flexible shafts avoid complicated (high-cost) gears, high tolerance alignments and can make difficult design situations possible. Flexible shafts, long known as speedometer cables, are not just doing the job in seat adjustments; today they are the solution in demanding head, ventilation, lighting adjustments, sun roofs or locking systems.

In power seats, each movement requires a small electric motor. These motors, sometimes 8-per-seat, can't always be placed exactly where needed. Using flexible shaft technology, motors are placed in the most practical place for the designer and transparent to passengers. Consider also door locking systems where car designs no longer permit solid shaft connection between the keyhole and the lock. A flexible shaft has given designers more freedom to create attractive designs for new models.

Experience and the right machinery, processes and knowledge assure you the best flexible shaft solution for the next innovation in cars. Self-opening doors, gliding doors, new convertible concepts, foot pedal adjustments and moveable back-up cameras are all projects in the pipeline for flexible shafts. **PTE**

For more information:

Suhner Manufacturing Inc.
P.O. Box 1234
Rome, GA 30162-1234
Phone: (706) 235-8046
michael.boehm@suhner.com

Guido Broder is VP and general manager of Suhner Manufacturing Inc.

Michael Boehm is director of marketing & sales, and global marketing coordinator for flexible shafts at Suhner Manufacturing Inc.

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Preventing Fretting Fatigue in Blade Dovetail Roots by Modifying Geometry of Contact Surfaces

Stephen Marsh

Introduction

Dovetails, gears, and splines have been widely used in aero engines where fretting is an important failure mode due to loading variation and vibration during extended service. Failure caused by fretting fatigue becomes a prominent issue when service time continues beyond 4,000 hours. In some cases, microslip at the edge of a contact zone can reduce the life by as much as 40–60 percent (Ref. 13).

As compressor and turbine blade speeds have increased with a reduced number of highly loaded stages, the root designs have moved from pin-fixed blades to either axial or circumferential dovetails. Axial dovetail fixings are usually employed in the design of the large civil fan blades, and for the front stage of either a military or commercial core compressor where sufficient edge-wise bending strength is required to meet demanding bird impact or foreign object damage. Circumferential blade root fixings have been used extensively by Pratt & Whitney and General Electric for many years in their gas turbine designs. It is a relatively new rotor blade attachment feature for Rolls-Royce for their compressor designs in both military and commercial applications.

On these blade root fixings, fretting can occur on the blade-to-disk contact faces of both components. Failure due to fretting in compressor/fan dovetail assemblies—manufactured from titanium alloys—is most often observed. With the increase of service time and reliability requirements of aero engine components, fretting fatigue should be paid more attention. Fatigue has always been a difficult and widely studied field, and introducing fretting complicates it further. While a means for completely eliminating fretting has yet to be discovered, many methods have

been suggested that increase life considerably (Ref. 5). Suitable care taken at the design stage to avoid known causes of fretting will minimize subsequent problems. One option the designer can control is the geometry of the interface, which is an important factor affecting contact stress and fretting behaviors.

Main Mechanisms in Blade Root Fretting

Blade root fretting can be divided roughly into two types, based on the relative movement between the root and slot. This movement can be seen because of the differences in thermal expansion and contraction between the contacting surfaces of blade root and drum groove. The vibrational modes of the blades and drum will also result in a slight, relative motion between the blade root and the disc slot surfaces, thus causing energy to dissipate and, in turn, lowering the amplitude of the vibrations. These factors are combined with the various rotating parts of the gas turbine, which themselves are also subjected to centrifugal loads during engine operation.

Such centrifugal loads will be either continuous or alternating, due to the different stages of the flight. The rotor disk can expand because of thermally induced loads, as well as mechanically induced centrifugal loads (Ref. 12). The severity of all types of fretting is, amongst other factors, a function of the movement present and the crushing stress; i.e.—for a given, relative movement, the degree of fretting will increase with the crushing stress.

High cycle fatigue. This failure mode can occur with aerofoil excitation in either flap or torsional modes, and it is the type of fretting most likely to result in problems of fretting fatigue (Ref. 3). The severity of this type of fretting



can be minimized by ensuring that the crushing stress does not exceed the critical property level for either in-contact material. In a fretting environment, high crushing stress can more readily lead to fatigue problems (Ref. 15). Root or under-platform damping is normally employed to reduce the blade frequency (Ref. 10).

Low cycle fatigue. This is caused by minute, radial relative movement between the blade root and disk, resulting in cyclic variation in slot width. With axial root fixings, circumferential growth of the disk rim on engine run-up causes dilation of the slot, allowing the root to move radially outwards. During the rundown the slot will close, forcing the root to return to its original position. With circumferential root fixings, the pattern of low cycle movement is more complex; as the disk or drum material carrying the groove is subjected to hoop stress, this, combined with centrifugal loading, will promote circumferential elongation of the groove during running. The blade root, however, is not subjected to hoop stress; this will result in microscopic relative movement/circumferential movement. There is also the possibility of some radial movement if the rotor construction enables the groove to “open” under conditions of bending or tension generated during running. This low cycle-type of movement can occur in combination with high cycle vibration, and can cause fretting in its own right, as often seen on the roots of “dummy” blade weights used on cyclic rigs where no aerofoils are present. Fretting can cause a considerable reduction in the fatigue strength of the materials involved, with titanium being particularly prone to this problem (Ref. 2). Therefore every effort should be made by the designer

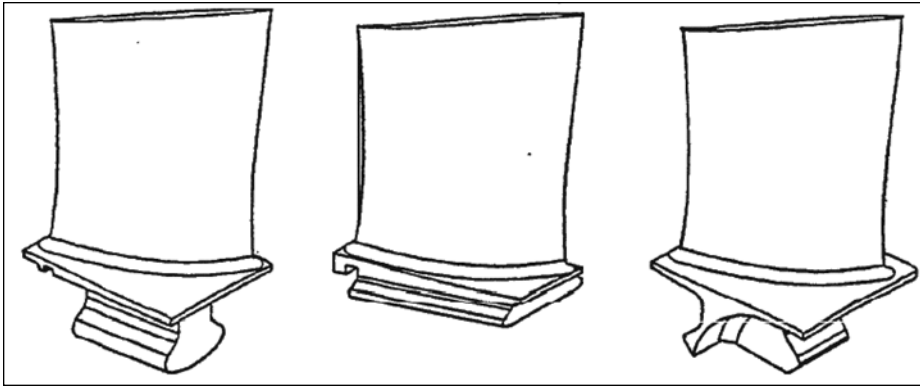


Figure 1 Diagram showing different types of blade root fixings with extended axial, non-extended axial and circumferential root dovetail with full-flank seal wings, from left to right.

to control the fatigue effects of fretting in highly stressed areas.

Microslipping at Edges of Interface

Slipping on a microscopic level will most likely occur at edges of the interface between the blade root and the slot of the disc, dictated simply by how the contacting faces behave. The coexistence of zones of sticking and microslipping is possible because of the deformable nature of the materials involved in the contacting areas, and because of the deformation pattern being such that it allows slip at the extremities of the contact zone. This argument states that even when no macroscopic motion occurs, some degree of microslip will exist and thus give rise to fretting (Ref. 6). For more complicated geometries, like the blade root interface with the blade and drum, these arguments, according to Halling (Ref. 6), are still qualitatively correct, and microslip will occur at the extremities of the contact zone.

Gabor Csaba (Ref. 4) has written a thesis that includes theoretical modeling, analysis and optimization of friction dampers. He writes of a damper model that had been developed named the “bar” model, which is a development of an existing damper model; this model has the ability to account for microslip. The bar model is relatively simple, yet complete enough to show the most important properties of a microslip friction interface like the interface between a blade root and disc.

Csaba’s ideas are fundamental in understanding how blade roots cause fretting if we were to treat the interface between the blade root contacting the

disc in the same way Csaba treats friction dampers as a bar model acting on a plain surface.

The behavior of the fretting mentioned (Ref. 4) demonstrates and details how the contact region experiencing microslipping can fluctuate by increasing and decreasing in area, and the rate of this fluctuation could have an effect on the rate of fretting and/or fretting fatigue. Csaba describes how this fluctuating area of microslipping grows and moves towards the center of a contacting region as the tangential loading increases. Then as the tangential load decreases, this area of microslipping will begin to shrink away from the center, back towards the edges of the contact zone (if macroscopic sliding doesn’t occur).

As the blade root and drum elastic constants differ, and given that the drum’s size is much greater than the blade, all of the components’ stiffness will differ relative to the other components; slip may then occur under a normal load due to centrifugal loading. The blade loadings (both tangential and centrifugal) on the top-side of the blade root, and the walls of the groove, will fluctuate due to changes in engine speed and compressor revolutions. This cyclic loading alone may induce microslip and promote fretting damage—thus inducing fatigue cracks in the fretting zone (Ref. 16). The failure of the blade root is caused by fretting fatigue cracking of the root, which then acts as a stress concentration. The crack can then propagate across the root due to high cycle fatigue, ultimately leading to complete failure of the blade.

We also need to consider the effects of friction damping and how it promotes fretting fatigue. Friction damping in blade dovetail attachments is often dominated by the microslip properties of the dovetail interface (Ref. 11), and because it has been shown that microslip can occur at the interface, it then must be decided whether friction damping is a curse or a blessing.

Allen, in his paper, “Friction Damping in Compressor Blade Dovetail Attachments” (Ref. 1), states that if friction damping is to be successfully employed in preventing blade failures due to vibration, then fretting wear and fretting fatigue must be seriously taken into account and given equal consideration relative to the benefits of friction damping.

While friction damping is evidently advantageous in limiting blade-resonant vibration, Lazan (Ref. 9) has highlighted in his *Damping of Materials and Members in Structural Mechanics*, that:

“For the case of dry interfaces (metal-to-metal contact) coulomb friction provides an important mechanism for dissipating energy under cyclic shear displacement. However, a joint optimized for maximum dry-slip damping is generally subject to serious fretting and corrosion effects in those interface regions having large cyclic slip. Such interface surface deterioration may cause the joint to drift from the optimum conditions of damping and may also initiate fatigue cracks, i.e.—the type of damage that high damping in a system exposed to resonant vibration is intended to mitigate. The cure may therefore lead to problems worse than the original problem (Ref. 9).”

Reducing Fretting Action by How the Contacting Surfaces Interact

Johnson (Ref. 7) says that an ideal solution to the problem of fretting is to eliminate all possibilities of microslip. In Johnson’s textbook *Contact Mechanics* (Ref. 7), he states that two lessons can be learned about avoiding microslip and ensuing fretting:

1. “(The) design should be arranged so that the line of action of the oscillating force is close to the direction of the common normal of the two mating surfaces.”
2. “(The) profiles of the two contacting surfaces should be designed so

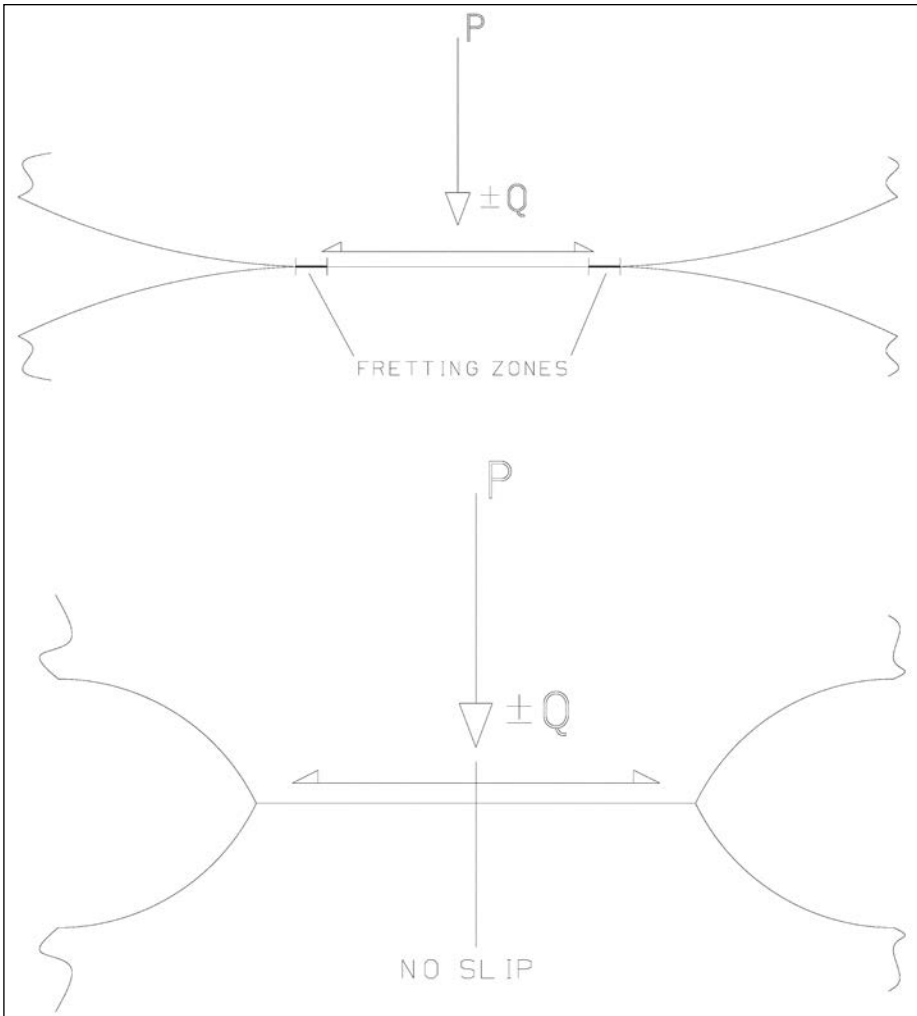


Figure 2 Top diagram shows common contacting surfaces; bottom diagram shows the “ideal” design solution (Ref. 7).

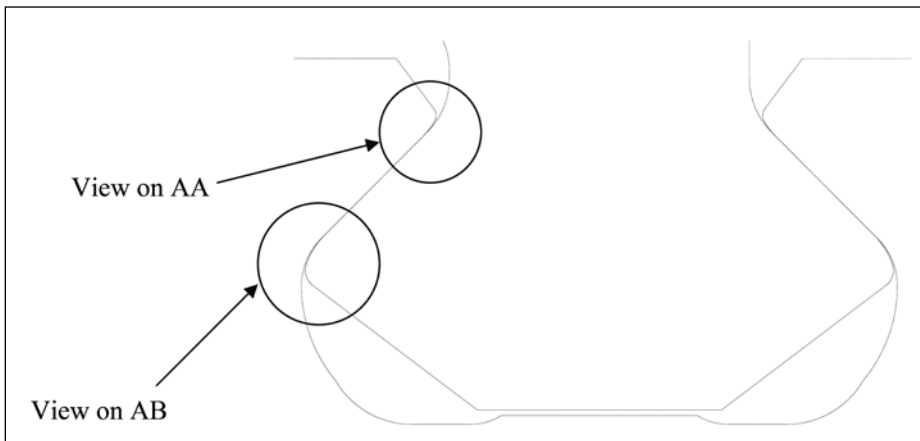


Figure 3 A typical circumferential blade root interface.

that, when they are in contact and under load, high concentrations of tangential traction at the edge of the contact area are avoided (Ref. 7).”

Figure 2 shows the influence of the profiles of contacting bodies on microslip and fretting. The top of Figure 2 shows how fretting occurs from common contacting bodies. The blade root has radii, or arcs, as part of its profile, so a similar scenario could occur when the root is pressed against the wall of the slot in the disc. The bottom diagram (Fig. 2) is the ideal design scenario. This means that any “sharp-notches,” which can arise at the edge of the contact of non-conforming surfaces, are to be avoided.

Re-Design of Blade Root to Reduce Fretting Fatigue

The methods of eliminating microslip learned from Johnson and O’Connor (Ref. 8) could possibly be applied to the actual blade roots themselves to prevent failure from fretting fatigue. It is not uncommon that small microcracks may propagate straight across the blade root and cause separation and total failure of the blade. If we were to eliminate microslip at the edges of contact between the axial/circumferential blade and disc slot, perhaps such fretting action could then be prevented—as well as failure from fretting fatigue and HCF (high cycle fatigue). Waterhouse (Ref. 14) states that the influence of the actual geometry of the contacting surfaces can greatly influence the design application. It is agreed that the incidence of fretting fatigue failure could be greatly reduced by attention to the design of contacting components at the drawing board and design stage of the blade root interface.

Figures 3–5 show what the contact surfaces look like for a typical circumferential blade root interface.

Figure 4 shows that the radius or exterior arc on the top of the root of the blade could be forced against the inside radius/interior arc on the slot of the disc due to HCF loading. Due to the fact that the materials are deformable and the CF is not constant, but fluctuating, the material is most likely to experience microslipping within this small region. As explained before, the

fluctuating growth of the microslipping area from the edges towards the center of a contacting region as the tangential/centrifugal loading increases, and then the shrinking of the microslipping area back from the center to the edges of the contact zone as the tangential/centrifugal load decreases, will most likely cause fretting at point AA.

Point AA, near the top of the dovetail flanks, is where most failures are seen on blade roots due to fretting fatigue. Allen (Ref. 1) has also shown that cracks can originate and propagate across the same spot, but on the slot of the disc—not just the blade.

At point AB (Fig. 5), the root of the blade will CF outward and fret against the wall of the slot on the drum (as described above); this is due to the deformable nature of any elastic material, like titanium.

If you were to remove some of the material by a chamfer, for example, to allow the blade root/disc slot to deform in these areas, then the material cannot rub/fret against anything, as the material has been removed. Figures 6–8 show how microslip could be eliminated by the use of a chamfer machined across the blade root to reduce any high concentrations of tangential traction at the edges.

Microslipping and therefore fretting could possibly be eliminated if the materials are allowed to deform due to the fluctuating centrifugal loads, but not contact one another.

The fretting at the upper edge of the bearing surface (points AA and AB) can initiate a small crack, which may propagate to failure if the alternating bending stress due to blade vibration is large enough. According to Waterhouse (Ref. 14) the undercutting of the neck of the dovetail could increase the fatigue strength of the blade by a factor of two.

Waterhouse states that the use of a relief radius at the flank edge greatly improved the fatigue behavior, and can prevent initiation of fatigue cracks. Figure 9 shows how the Waterhouse relief radius can be incorporated into the circumferential blade root design.

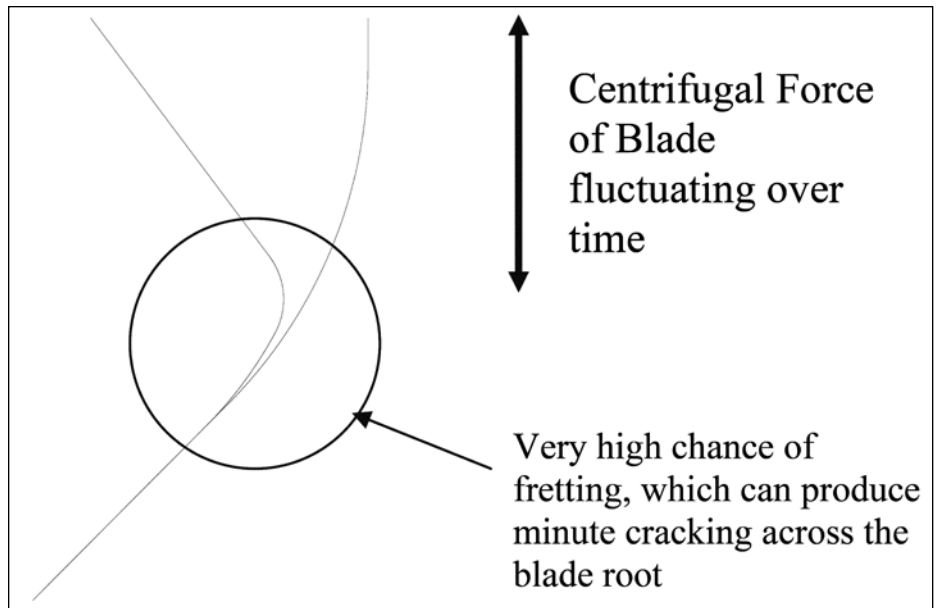


Figure 4 View of Point AA.

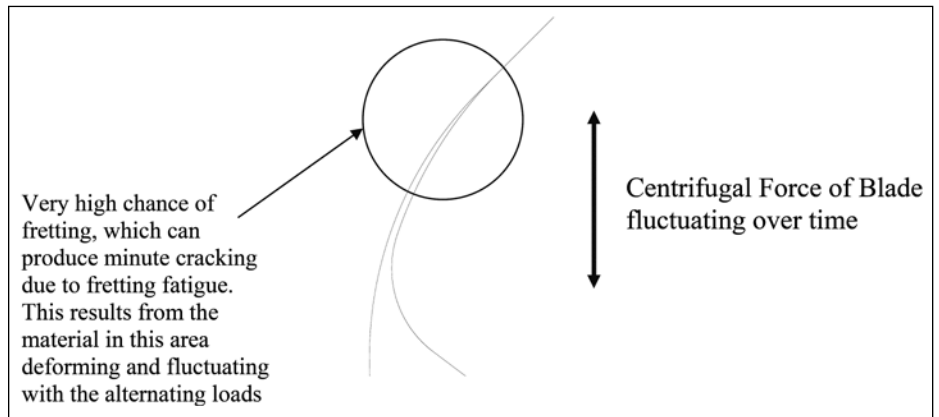


Figure 5 View of AB.

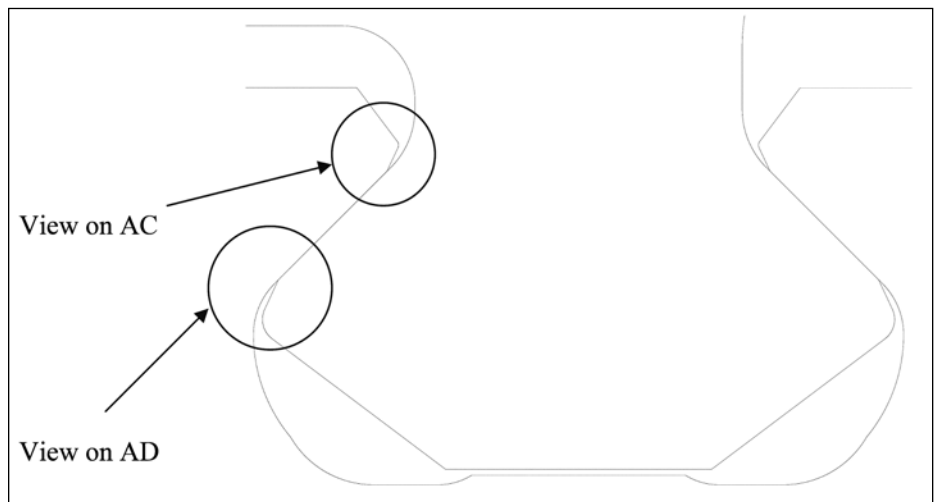


Figure 6 The use of chamfers to eliminate microslip, therefore fretting.

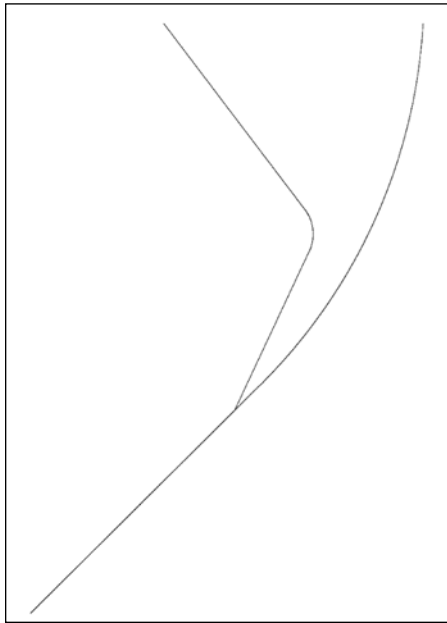


Figure 7 The use of a chamfer to eliminate microslip at Point AC.

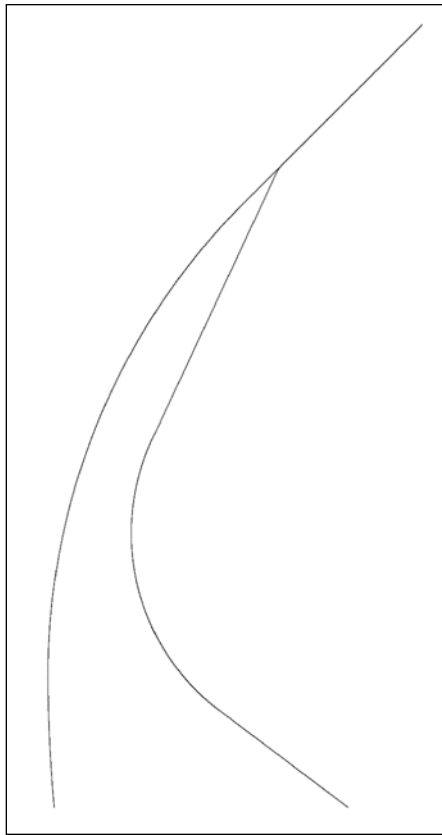


Figure 8 The use of a chamfer to eliminate microslip at Point AD.

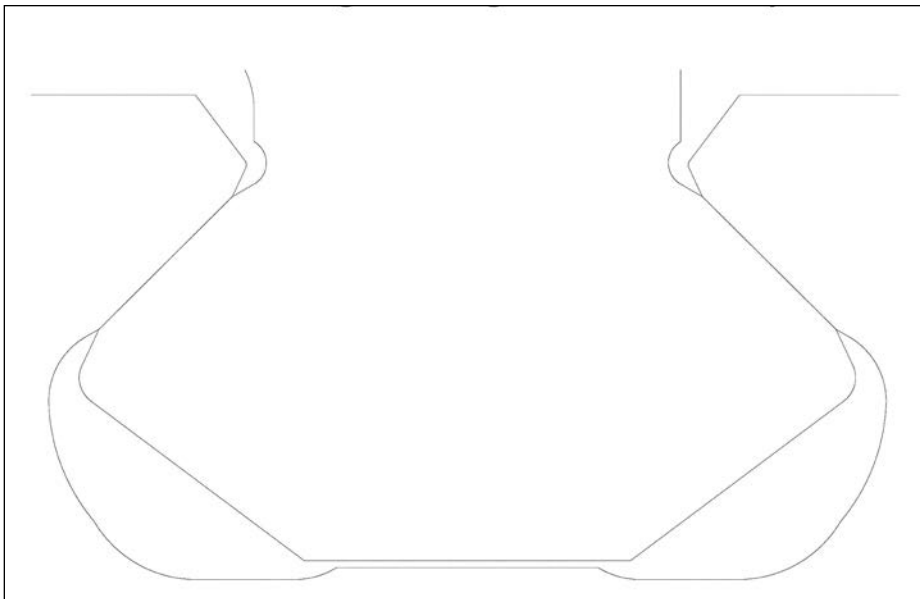


Figure 9 The use of an undercutting and a relief radius on the blade slot and the slot of the disc.

Simpler Method of Manufacture

Another advantage of this design is the fact that the geometry is now simpler. Usually the edges of the blade root are manually rounded. But now that the rounded edges and arcs are gone and replaced with flat chamfers, it is simpler and easier to manufacture and can be reproduced many times on different blade roots. The dependence on the skill of a technician and the variations in dimensions due to different technicians' abilities, etc., is completely removed. The contacting faces on the blade and inside the slot on the disc can be exactly dimensioned on a drawing, and with suitable manufacturing methods achieve the dimensions specified on the drawing. This allows the area of contact to receive equal mechanical loading between all the blades because the mating surfaces are no longer considered "Hertzian," and are now completely flat.

Other Applications

This simple modification to the geometry of the blade root can be applied to axial blade roots and circumferential blade roots on all the stages of a gas turbine compressor, including the main fan stage. This geometry can also be applied to the fir tree roots of turbine blades. Another application is for involute gears, where it could possibly prevent fatigue in the roots of gear teeth. **PTE**

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Stephen Marsh is an incorporated engineer (IEng) with the Engineering Council (U.K.) and the Institution of Mechanical Engineers, working primarily in the aerospace and nuclear industries. He began in 2000



a technical modern apprenticeship and an HNC in mechanical engineering with Rolls-Royce plc., and in 2005 graduated from the University of Central England with a BEng (Hons) degree in mechanical engineering, while working as a CAD engineer and draftsman on the HP compressor for the V2500 International Aero engines. Marsh later transferred to the Civil Aerospace Group—Transmissions, Structures and Drives in 2007, working on projects such as Trent 900, Trent 1000, ANTL and EFE. He subsequently changed industries, moving to the nuclear sector as a design engineer for Nuclear Engineering Services Ltd., and then to UTC Aerospace Systems (formerly Goodrich Actuation Systems), where he currently works as a concept design engineer on projects such as designing the hydraulic actuators for the thrust reverser actuation system (TRAS) on the A320 NEO and designing the gearboxes and telescopic coupling for the variable-area fan nozzle (VAFN) actuation system.

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Brush DC Motor Runs Along

Dan Jones, Incremotion Associates

Everything started in 1800 when Volta developed the first DC battery. Faraday used the DC battery to develop the first electric motor. It used brushes to transfer the battery voltage and current to the rotating disk rotor. This was in mid-1831. Thus was born the brush DC motor.

Construction

The slotted brush DC motor of today comes in two basic configurations: the wound field DC motor and the permanent magnet DC motor. The key parts of a DC motor include the armature (the rotating part), the field (either a copper winding or permanent magnet), and a mechanical commutation system consisting of a slotted commutator, mechanical brushes with copper wires connecting to outside terminals. The commutator is connected to various windings in a sequential pattern. The two brushes ride on the commutator to connect to the battery or outside power source via the terminals as shown in Figure 1. These brush DC motor types are called slotted or iron core types.

Motor Operation

The DC motor is the simplest motor type. Raise the input voltage and the motor speeds up. Lower the voltage and it reduces speed. Increase the motor's shaft load and shaft torque and armature current go up while the speed goes down. The permanent magnet DC motor is the most popular type, replacing the three wound field DC motors in many applications. Today the most popular wound field DC motor has another name—the universal motor—a separate motor type because it can be driven by AC and DC input power. The permanent magnet DC motor version operates linearly as shown in Figure 2. It is a simple motor to control with an outside variable DC power controller.

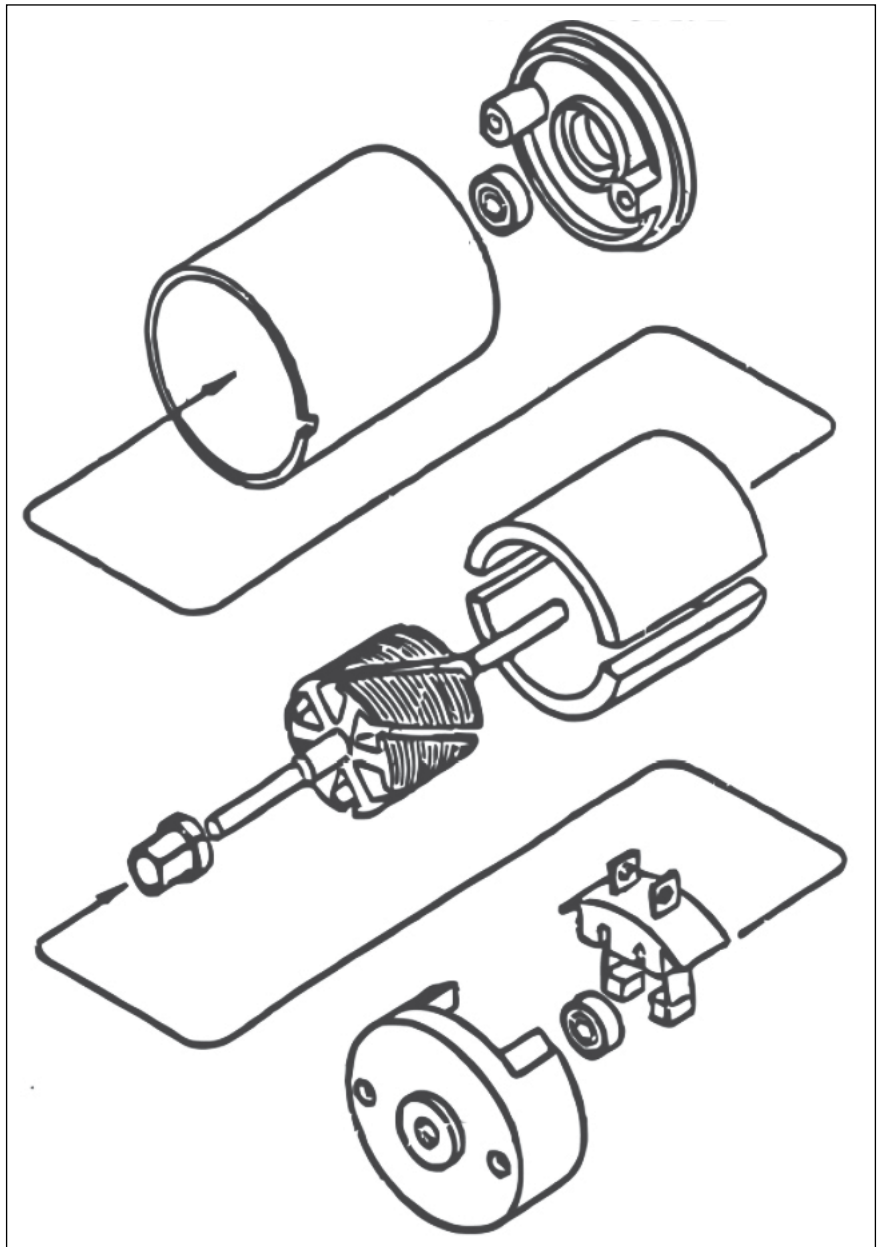


Figure 1 Permanent magnet DC motor structure.

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If it is so simple to control, why then is it being replaced in a wide range of applications? Well, the answer lies in the motor's life expectancy based on brush wear and the resulting motor life.

Commutation System

It's the wearing away of the carbon or metal graphite brushes that concerns many. The mechanical contact between the brush and the commutation transfers voltage and current to the armature necessary to generate motor torque and speed. Since the brush wear can vary under different current and speed combinations (and it is *supposed* to wear, but not too quickly), it is very difficult to predict motor operating life. Motor design engineers usually have experience with a number of brush grades that they can hopefully rely upon for use in new applications. The brush manufacturers can also assist the motor designer in selecting the "right" brush grade.

Motor Variations

New applications foster new variations for all motor types, and the brush DC motor is no different. The ironless DC motor is also called a coreless or slotless DC motor. Developed just after World War II in Switzerland, the ironless DC motor eliminates the armature teeth. Its armature is constructed as a self-supporting copper wire winding basket supported by an epoxy resin cylinder.

The permanent magnets occupy a central position inside the copper winding basket. This construction reduces the winding inductance into the microhenry range. Silver brushes are used to reduce motor resistance, allowing this motor type to reach rated power efficiencies above 90 percent. Almost all power output performance is below 100 watts for the ironless motor types.

Another form of brush motor is the permanent magnet brush disk DC motor, very popular in the 1960s through

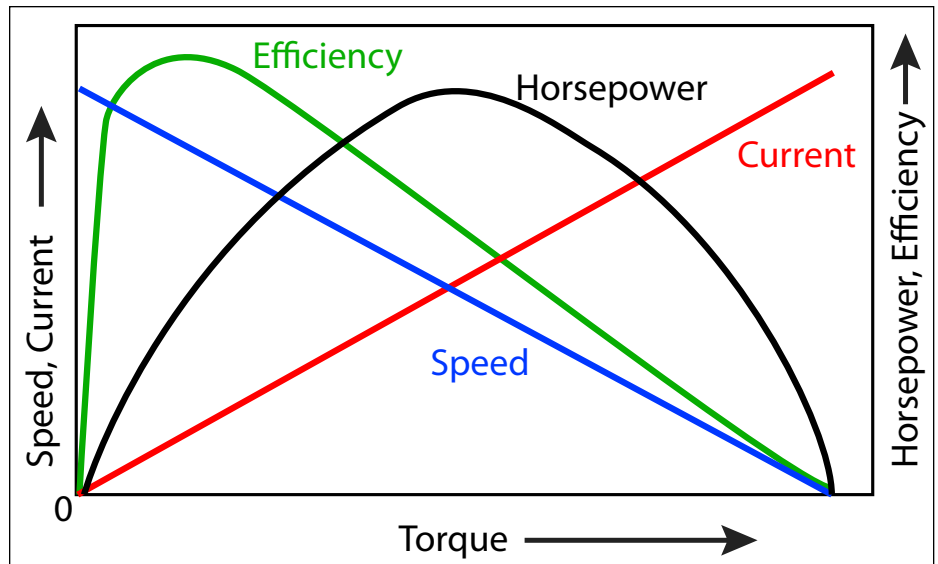


Figure 2 Full speed/torque curve for a permanent magnet DC motor.


the 1990s and still made today. They would be classified today as axial flux DC motors. They produce lots of torque. Their armatures are multi-copper sheets in a thin pancake configuration.

Typical Applications

While slotted brush DC motors still have many applications, particularly in automotive auxiliary applications (windshield wipers, window lift motors and seat adjust motors), the brushless DC motor (a competing technology) is slowly gaining market share against the slotted and the ironless brush DC motor.

The ironless DC motor has its market niche in medical pumps, blood pumps, precision scales, small robots, and many other applications. One can expect the brush DC motor to be used in a myriad of applications for many years to come. **PTE**

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



PowderMet 2013

Design Excellence Awards Demonstrate New PM Technologies

Winning parts in the 2013 Powder Metallurgy (PM) Design Excellence Awards competition aptly demonstrate that the technology is not resting on its laurels. While capitalizing on PM's traditional strengths—net-shape capabilities that contribute to lean operations, energy and materials savings that enable more sustainable manufacturing, and significant economic advantages that have always been a hallmark—these exemplary components, fabricated via both conventional PM and metal injection molding (MIM), signal a push into new territories.

Grand Prize Awards

Indo-US MIM Tec Pvt. Ltd. from Bangalore, India, earned a grand prize in the automotive—engine category for a sensing element, a threaded port, and a support ring made for Sensata Technologies Holland B.V. from Almelo, the Netherlands. Fabricated via MIM, these components are used in a sensor kit that measures the inlet pressure of the air-fuel mixture in each cylinder of a passenger car engine. The length of the threaded port creates complexity, as do the thin walls and fragile features, and the stringent customer requirements on visual aspects add to the difficulty of fabrication. This new application is estimated to save the customer 50% over the cost of fabrication using alternate technologies.

AMES S.A. from Barcelona, Spain, was awarded a grand prize in the automotive—chassis category for a compressor clutch that is part of an assembly in a braking system for heavy trucks and buses. The system stops the compressor once the necessary air pressure is reached, which saves energy and helps reduce the vehicle's fuel consumption by seven percent. Made of a diffusion-alloyed steel, the complex part is compacted on a CNC 400 mt press at a pressure of >87,000 psi to achieve a required density >7.0 g/cm³ in any point of the part. Other properties include 66,000 psi yield strength,



2013 grand prize winners include raptor jaws (foreground), sensing element, port & ring, and tool holder assembly (first row), compressor clutch, U-bracket & stop, and motor core stator (second row) and transmission rotor (back row).

103,000 psi ultimate tensile strength, 1% elongation, and 85 HRB hardness. PM was the only technology capable of producing this part at the customer's cost target.

Capstan Tennessee Inc. of Rockwood, Tennessee, was given the grand prize in the lawn & garden/off-highway category for a transmission rotor made for Caterpillar Inc. of Peoria, Illinois. The rotor mates with a magnetic sensor that reads the rotating teeth to generate speed data used for controlling the shift point of transmissions powering large off-highway construction vehicles. Made of carbon steel, this single-level part is pressed to a density of 6.85 g/cm³, sintered, and then re-pressed to 7.00 g/cm³.

Claw pole motor core stators made by Burgess-Norton Mfg. Co. of Geneva, Illinois, won the grand prize in the hardware/appliances category. The parts are used to generate a magnetic flux that interacts with a rotor and permanent magnets to produce torque in a high-efficiency brushless DC motor in an electric ceiling fan. Both halves of the motor core are produced using one set of tools: heated fixed-fill shelf die, core rod, single upper punch, and six thin-walled lower fill punches. Formed from a high-compressibility inorganically insulated iron powder, the parts are compacted with pressures exceeding 67 tsi to a density range of 7.4–7.5 g/cm³, typical ultimate tensile strength of 7,000 psi, and 19,000 psi transverse

rupture strength. The parts are compacted to net shape and require no secondary operations. They belong to a new generation of DC motors using soft magnetic composite PM materials to enable greater design freedom for designers of electric machines.

Indo-US MIM Tec Pvt. Ltd. of Bangalore, India, received the grand prize in the hand tools/recreation category for a tool holder assembly made for Scintilla AG of Solothurn, Switzerland. The assembly that incorporates these two MIM parts—a tool holder and a grip-spring tensioning part—goes into a woodworking tool for fine-detail carving. Part complexity made MIM the obvious fabrication choice: no other technology could produce the part as an integral unit and deliver it in the needed volumes at the target cost. Made of a low-alloy steel, the parts are supplied in the heat-treated condition. Properties include 7.5 g/cm³ minimum density, 225,000 psi ultimate tensile strength, and 200,000 psi yield strength. To overcome the possibility of distortion on the unsupported open end, the design provided

supporting ribs. The grip support ring was produced per print with the help of one turning operation. The MIM design contributes to a lean operation for the customer by substantially reducing lead time through the elimination of many processing steps.

Polymer Technologies Inc. of Clifton, New Jersey, earned the grand prize in the aerospace/military category for two MIM parts—U-bracket and stop—used in a Feedbox Support Improvement Kit (FSIK) for an M249 squad automatic weapon (SAW) used by the U.S. Military. The device is designed to hold various-size high-volume magazine ammunition packs securely to the gun. It extends the service life of the weapon by enabling the soldier to repair it in the field, thus avoiding the cost to taxpayers of a new weapon, which can be as high as \$3,200. Drop testing of the firearm with the device attached proved the integrity of the FSIK even while other components were damaged. The innovative I-beam and webbing design allowed the parts to meet the 32–38 HRC hardness range requirement and still maintain the to-

tal weight of the kit below 3.5 oz. Molded from MIM-17-4 PH stainless steel, the parts have >7.5 g/cm³ density, 130,000 psi ultimate tensile strength, 106,000 psi yield strength, and 6% elongation. The only secondary processing of these near-net shaped parts are a coining operation to the bracket in order to achieve the tolerance required for the distance between the notch and the through-hole, as well as tapping the hole to provide necessary threading. Both parts are black oxidized to remove their reflective properties, a critical consideration for the safety of the soldier.

FloMet LLC/A QMT Company of Deland, Florida, was awarded the grand prize in the medical/dental category for a 17-4 PH stainless steel jaw made for US Endoscopy, Mentor, Ohio, and used in a Raptor grasping device. Made via MIM, the jaws merge into one design the features of both a “rat tooth” jaw and an “alligator” jaw, combining the functions of a grasper and a retrieval forceps that surgeons use to retrieve foreign objects in the body during minimally invasive procedures. The component design is enormously complex due to its small size, thin-wall requirements 0.25 mm (0.010 in.), and features required to achieve full functionality with the sharp talons and teeth at net shape. The parts have >7.5 g/cm³ density, 130,000 psi ultimate tensile strength, 106,000 psi yield strength, 6% elongation, and 27 HRB hardness.

Additionally, awards of distinction were given to companies including Indo-US MIM Tec, GKN Sinter Metals, Burgess-Norton Mfg., ASCO Sintering, FMS Corporation, Parmatech Corp., FMS Corp. and Polymer Technology Inc.

The awards were presented during PowderMet 2013 in Chicago, Illinois June 24–27. **PTE**

For more information:

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2013 award of distinction winners include shuttle (first row), actuator and fuel control gear segment (second row), star shifter, hub adaptor and rack and pinion (third row) and rear cam cap and ramp plate (back row).

Global Distributed Gear Production

IS IT CONSIDERED OFF-SHORING ANYMORE, OR SIMPLY A BASIC REQUIREMENT FOR SUCCESSFUL LONG-TERM GROWTH?

Two significant gear producers from different ends of the market in terms of volume have recently invested in additional manufacturing plants in Asia and India. Is this investment in distributed geographic production the risk it once was, or is it just a natural step towards servicing global customers in a global market?

Terry Grubb, managing director of U.K. precision gear and aerospace contract manufacturing company Microprecision, and **Karl-Peter Simon**, managing director of Bauer and senior vice president of geared motors for Altra, both express common motivation for similar expansion and investment decisions.

Microprecision is a niche market player with a serious portfolio of clients. It has invested in building a technology and manufacturing center in Bangalore, India in order to service local customers and



Terry Grubb

increase volume production, whilst German gearmotor manufacturer Bauer has invested in production in Eastern Europe and now China in order to provide service to global customers locally.

There is a theme here that follows the automotive model; after global car manufacturers and electronics giants had shown how large-scale distributed manufacturing can be made to work on a global scale



Karl-Peter Simon

— by using localized production facilities, there was a wave of initial investment in SME offshore manufacturing in the late 80s and 90s.

This move, essentially a cost cutting exercise, resulted in very bad press for many European, U.S. and even Japanese SME companies, as the drive to reduce costs resulted in loss of IP, quality issues and reduced investment in home markets. Many manufacturers pulled out of JVs and similar operations to re-shore their production and gain control over development and quality in the 2000s.

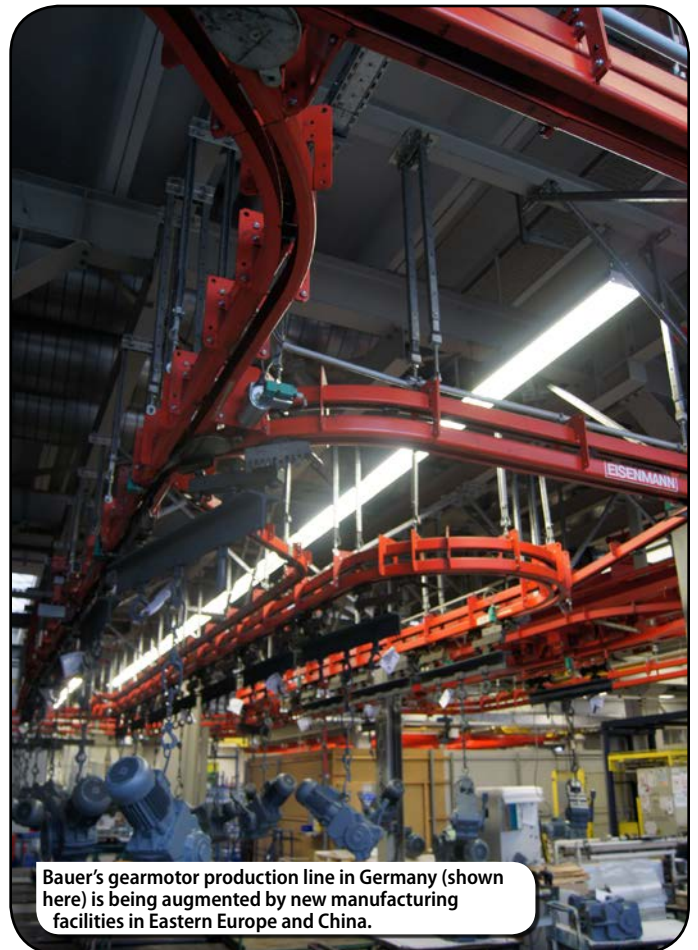
If you consider that the first wave, then the second wave is definitely not looking to establish low-cost manufacturing to re-export product into existing markets. The focus now is in supporting customers who are successfully manufacturing within fast developing economies and require the same products and subcontract/supplier support that they enjoy in their other global manufacturing bases.

Is this a safer place to be for SMEs now, allowing global expansion, and does it fit better into the deployment of a larger

business globally? Microprecision fits the high-technology SME profile to a tee, selling advanced, often niche low-volume products at a premium based on the application of design and production knowledge and experience.

Bauer, on the other hand, is part of the Altra Industrial Motion Group, headquartered in South Beloit, Wisconsin and is now the world's largest producer of industrial clutches, brakes, couplings and geared motor products. The sheer volume of its production capability in Germany and abroad makes it a substantial global player. The expressed intention from both businesses is, however, remarkably similar, and the hopes and aspirations, backed-up by direct experience, are also similar.

“Our production facility in India is different to our U.K. operation; it's a clean sheet of paper build for a start, but it is driven by the global demands of our customers,” said Grubb. “There is a growing and thriving aerospace community in India, partly thanks to government funding and partly due to the high caliber of local engineering talent. We may export some of the products we make in India in larger volumes, such as precision gear pumps, and many of the aerospace components we make in short batches will continue to be manufactured at our HQ in the U.K., but for small-to-medium size volumes of product that need to be supplied locally,



Bauer's gearmotor production line in Germany (shown here) is being augmented by new manufacturing facilities in Eastern Europe and China.

the new India base is ideal. A common business language helps, but it is by no means essential to our decision to expand in India. We find that business is global now, especially for the larger aerospace, medical and automotive customers we have, so if we are to grow with our client base we needed to expand abroad.”

A major public step in Bauer’s current business expansion plan was taken when the company opened a new assembly plant in China. Contrary to current trends, the facility was established to provide local availability to customers already operating in China and develop local business, not, as other manufacturers had done, to seek a low-cost manufacturing base to import products back into Europe.



“Since building the world’s first commercially available range of gear motors, Bauer has been recognized as a pioneer in the technology,” Simon said. “Under Altra’s commercial umbrella we now find ourselves in a position where we can look at the emerging markets, especially the BRIC countries, and grow our global presence. With this goal in mind, the opening of our new facility in China was a natural step. China is currently the fastest growing economy in the world, and with its recent announcement of a five-year plan that connects its growth to increased efficiency, our products now have an even more relevant position in this market.

“While other manufacturers still move to China in order to reduce the production costs on the products they sell to Europe, we have moved to China to support our existing business there and to create the foundations required

to develop new business for the local Chinese market. The plant assembles and stocks our key products, which reduces lead times on new motors and replacement parts significantly. This means we can offer the same level of Bauer quality and support in Asia that is enjoyed by our European customers at a competitive price, locally.”

For some gear production companies then, both SMEs and larger manufacturers, multiple production sites around the world are now a reality, not to drive down global costs, but to support customers wherever they are in the world, reducing transport and logistics time and cost and therefore making gear production globally not ‘cheap’ but far more cost effective and efficient overall.

POWER TRANSMISSION AND CONTROL 2013



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30521 Hannover, Germany

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Wittenstein

ANNOUNCES NORTH AMERICA CEO

The Wittenstein Group, a global provider of mechanical and electro-mechanical motion control systems, has named **Peter Riehle** as president & CEO for Wittenstein North America. In this role, Riehle will be responsible to extend Wittenstein's reach into highly specialized industrial markets such as packaging automation, semiconductor manufacturing, robotics, aerospace and simulation. He comes to Wittenstein with an extensive background in the precision technology and machine tool industries. Based in North America for over 16 years, he has held senior executive positions at the Schaeffler Group, DMG America, Weinig Inc., and Trumpf. This announcement comes as Wittenstein expands their U.S. based manufacturing facility, and during the launch of their new cyber motor business unit in North America.



Timken

APPOINTS GENERAL MANAGER OF WIND ENERGY

The Timken Company recently announced the appointment of **Bradley K. Baldwin** to general manager of wind energy. Baldwin joined Timken in 1995 as a sales engineer in Charlotte, N.C. He has held sales leadership positions involving automotive, industrial and distribution customers. Baldwin has served in management positions as well, most recently as general manager of process industries original equipment sales for Asia and wind aftermarket business development. A native of San Angelo, Texas, Baldwin earned a bachelor's degree in mechanical engineering from Texas A&M University in College Station, Texas. He is a member of the American Wind Energy Association.



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QA1

NAMES SCOLES PRESIDENT

QA1, an industry leader in performance shocks, rod ends and suspension components for motorsports, is excited to announce the promotion of **Melissa Scoles** to president. CEO and Founder Jim Jordan announced the news, stating "QA1 is fortunate to have someone with Melissa's broad skillsets to assume this position within the company."



Scoles has been associated with QA1 since she was a teenager, as Jordan is her father. She started at the company folding boxes and worked the company's trade shows during college. She then worked through every department at the company, taking a break to get outside experience and attain her MBA from Carlson School of Management. She studied in both Europe and Asia while earning her degrees. When she returned in January of 2011, she joined the QA1 team again as vice president of marketing, to be quickly promoted to executive vice president and now president.

In the past couple of years, Scoles has helped lead the company to several milestones. She oversaw the acquisition of CAP Auto Products and Edelbrock's Suspension Division, adding over 350 American-made suspension products to QA1's product offering. She has also been integral in organizing QA1's new Composite Component Group, which will be introducing a variety of carbon fiber filament wound products to the market for late 2013 and 2014. Currently, she is leading a project to expand QA1's manufacturing space to accommodate the company's growth over the past couple of years.

Hartford Technologies

APPOINTS SALES ENGINEER

Hartford Technologies announces the appointment of **Dave Kelley** as sales engineer for the Great Lakes and Midwest Region. Kelley has extensive experience with application engineering for bearing products, including precision balls, needle rollers, dowel pins, cages, and custom bearing assemblies. He will provide ongoing support for Hartford's expanding customer base from his Michigan office. Hartford Technologies is a leading global manufacturer of precision metal components for OEM applications, with TS/ISO certified manufacturing facilities in the United States and China.



Motion Industries

RELEASES LATEST MIHOW2 VIDEO

Motion Industries, a distributor of industrial maintenance, repair, and operation (MRO) replacement parts, has released a new video on their "MiHow2" channel (www.mihow2.com), the product/application solutions series. The instructive video series' goal is to share practical industrial applications that viewers can adapt in their own facilities.

A supplier of cable and hose carrier/management systems, Tsubaki KabelSchlepp performs the demonstration in the video titled, "How to Increase the Life of Your Cables and Hoses in a Dynamic Cable Carrier." The video can now be viewed online at www.mihow2.com.



"Maximizing the life of any part is important to all companies watching their bottom line," said Randy Breaux, Motion Industries' senior vice president of marketing, product management and strategic planning. "I think Tsubaki KabelSchlepp demonstrates this process well by showing how a properly sized carrier, coupled with the correct cable and hose choice and installation, can avert pre-mature failure."

Each MiHow2 video was filmed in a workshop setting, and features the Motion Industries host with a guest from one of the market-leading industrial manufacturers—demonstrating a product or application. Additional MiHow2 videos are scheduled to be posted to the new channel in coming weeks and throughout 2013.

Napoleon Engineering

ANNOUNCES CUSTOM BEARING CAPABILITIES

Napoleon Engineering Services (NES), an ISO9001:2008 and AS9100C certified custom bearing manufacturing, bearing inspection and bearing testing facility, has announced its complete custom bearing manufacturing capabilities for spacecraft, satellites, launch vehicles, rotorcraft, and other aerospace related requirements.

With a core competency in high-precision custom ball and roller bearings using superelastic Ni-Ti alloys; wear resistant, high life materials and coatings; and advanced design technologies, the company has cemented its position as a key resource for bearing manufacturers, distributors and related OEMs.



Specific to aerospace and space-related technologies, NES products and services support a diverse range of applications, including, but not limited to satellite arm actuation, antennas, fuel pumps, ram air turbines, and rocket engine valves. In addition, the company's bearing manufacturing is complemented by its unique capability to offer highly specialized programs into this market sector, including the reverse engineering of Typed Certified aircraft bearings for FAA Certification, required for bearing OEMs which were not integrated into an aircraft at the point of initial design, and who are seeking their own PMA.

AutomationDirect

LAUNCHES NEW MERIT BADGE WITH BOY SCOUTS

AutomationDirect.com has teamed up with the Boy Scouts of America to inform and inspire the nation's youth about programming. The 2013 National Boy Scout Jamboree was held in mid-July at the Summit Bechtel Reserve in the mountains of West Virginia, where AutomationDirect, Radio Shack, VEX and the Boy Scouts of America launched the brand new Programming Merit Badge.

The new merit badge is designed to introduce youth to various kinds of software programming. At the National Jamboree, 40,000 Scouts had the opportunity to learn about the Programming Merit Badge using tutorials to understand programming theory for embedded controllers, robotics, and



ladder logic using the CLICK PLC. Scouts then performed the different programming tasks in order to receive the new Merit Badge. Reports indicate over 800 Scouts lined up to earn the new badge. The Programming Merit Badge is available to all Scouts through the Scouting Merit Badge Program.

Joan Welty, marketing director for AutomationDirect.com says, "AutomationDirect is extremely excited to participate in getting this new Programming Merit Badge introduced to the Scouts. We believe that the future of our industry lies with the talented minds of our youth and we want to do everything possible to encourage them to explore the exciting world of factory automation. During this 10-day Jamboree, several thousand young people have learned just how intuitive programming can be with ladder logic and the CLICK PLC. This is a big win for the future of factory automation and the manufacturing industry, and we are proud to play a part."

Stober Drives

EXPANDS U.S. OPERATIONS

Stober Drives, Inc. has added a 50,000 square foot building to its Maysville, Ky. campus to maintain its reputation as providing the best people, processes, products, and performance in the drives industry. "We believe in unsurpassed customer service support, including fast delivery," said Peter Feil, general manager at Stober Drives. "We have a standard delivery of one day. The fast delivery is not the result of a stock of preassembled gearboxes. Every unit is built to order to match customer specifications."



Stober manufactures quiet, highly-efficient, durable gearboxes. Focusing on motion control and power transmission, Stober has expanded into the global market for applications including robotics, material handling, packaging, machine tool, medical equipment, food, beverage, semiconductor manufacturing, aerospace equipment, printing, and general automation application.

"This expansion is all a part of our emphasis on being the gold standard in the industry," said Feil. "The additional space has allowed assembly, customer support and shipping to grow, maintaining our focus on giving the customer

the best experience possible. All phone calls are answered within three rings or less, quotes are completed in one hour, and every unit is shipped filled with application specific lubricant."

Stober is especially sensitive to customers who are in a breakdown situation. Emergency orders have no expediting fee and are shipped in 24 hours or less.

"Downtime is huge because all operations stop until a company is able to get a new part," said Feil. "We are the company people can rely on to get them up and running again." Emergency support is available 24 hours a day, seven days a week for any location in the United States.

Igus

CONTINUES GROWTH TREND

Igus Inc. is continuing its growth trend. Despite difficult market conditions in 2012, Igus managed to increase turnover by five percent and finished the year on a record high. Igus is counting on "organic growth" this year, too. Within the context of a long-term investment program, significant capital will be directed at new product divisions, the expansion of existing product lines as well as global logistics and production. In 2012, Igus supplied products to more than 175,000 customers all over the world and was able to ship more than 4,200 shipments in average per day from its 13 global dis-



patch centers. The ReadyChain division – pre-harnessed Energy Chains and Igus continuous-flex Chainflex cables – grew at an astonishing high rate: around 341,000 pre-harnessed cable systems left world-wide production facilities last year. Igus is expecting additional growth from new product groups including semi-finished goods, ball bearings, spindle drives, electric actuators, and on-site assembly programs. Each product is now developed and marketed in separate business divisions with additional staff, space and production facilities. The number of employees increased last year to a total of 2,175, a seven percent increase. For customers, things remain simple. As before, they can contact sales engineers for Energy Chain Systems and for dry-running bearing technology. In addition, there is an expanded team of industry

specialists providing support to sales engineers in the fields of machine tools, packaging machines, construction machinery, cranes, the agricultural sector, material handling, medical technology, energy sector, automotive production and robotics.

Hoerbiger

MAKES CHANGES TO DRIVE TECHNOLOGY SEGMENT

On July 17, 2013, the board of directors of Hoerbiger Holding AG gave the green light for a generational change at the top executive level of the strategic business unit drive technology. At his own request, **Dr. Siegmund Schlagau**, member of the Hoerbiger Group executive board and head of the strategic business unit drive technology, will relinquish all his management responsibilities at the Hoerbiger Group in several steps during the coming months. He will be succeeded by **Thomas Englmann**, currently managing director of Hoerbiger Kompressortechnik GmbH, Schongau, and head of serial compressors business segment. He will be assuming responsibility for the strategic business unit drive technol-



ogy in several stages beginning in September. A successor has also already been found for Englmann from within the Group: Oliver Gratzel. He is currently head of the hydraulics and pneumatics segments in the automotive comfort systems business division.



Englmann, an industrial engineer, has been an expert in the automotive business for many years. Even before he started working for Hoerbiger, he had already held several executive functions for a supplier in the industry. He has been managing director at Hoerbiger

Kompressortechnik GmbH, Schongau, since 2006 and is responsible for various product categories that are developed worldwide, produced and delivered to global and local customers for many years. Over the past few years, he built up the important future markets of China and India for his Serial Compressors Business Segment.

"It's time to make room for the next generation!" says Schlagau. "It's important to me that I hand over the reins with sufficient time." He will stay with the company as a consultant after handing over his responsibilities.

Under the leadership of Schlagau the strategic business unit was strategically repositioned through wide-reaching changes over the past few years. The systematic focus on the synchronisation technology business segment for passenger car transmissions has proven its value. New, innovative products that will once again set standards in the industry

are ready for the market. The Hoerbiger CompactLINE synchronization was recently introduced. It uses a unique functional principle. It offers significant savings in weight and size, while still providing the greatest level of comfort when changing gears.

Englmann will assume responsibility for around 1,600 employees across six locations in Germany, China and Canada. "It is important to us to ensure that such a complex role can be handed over to the successor with as much care as possible," says Dr Martin Komischke, CEO and chairman of the Hoerbiger Holding AG executive board. "For this reason, the board of directors and executive board have reached an agreement with Schlagau and Englmann under which these responsibilities will be transferred in several stages."

This ensures a seamless transition in management for both the serial compressors business segment and at Hoerbiger Kompressortechnik GmbH. Gratzel, also an industrial engineer, will be taking over the reins there on September 1, 2013. Over the past few years, Gratzel has made a significant contribution with innovative, competitive product concepts and new strategies, to help lead this business division out of a difficult crisis.

"Thomas Englmann and Oliver Gratzel, the two executives who will be moving up into new, responsible positions, have shown what they are capable of over the past few years at the Hoerbiger Group," says CEO Dr. Martin Komischke. Hoerbiger targets managerial staff and employees for promotion with the goal of retaining good employees at all levels in the company, to develop them and offer suitable career prospects.

Schaeffler

DESTROYS 26 TONS OF COUNTERFEIT ROLLING BEARINGS

Rolling bearings of various types and sizes are conveyed by the gripper arm of an excavator into a scrap press with a loud crash. The bearings leave the press chopped and broken into pieces or so badly damaged that they are rendered unusable. Large-size bearings with an outside diameter of more than one meter, which are even too big for the scrap press, are destroyed with a cutting torch. All these bearings are counterfeit products marked with the INA and FAG brand, which were confiscated in raids. The objective of this operation is to make these bearings unusable.

After a spectacular operation in 2007, in which around 40 tons of counterfeit bearings were destroyed at the Schaeffler company site in Schweinfurt, and numerous other operations to destroy counterfeit goods worldwide, around 26 tons of counterfeit bearings with a value of more than one million euros were destroyed this time at the premises of INTERSEROH Franken Rohstoff GmbH in Schweinfurt. A large proportion of the counterfeit products originate from raids at bearing distributors in Europe, for example, in Italy and Great Britain. But some of the counterfeit bearings are also from Germany. "Brand and product piracy is not a phenomenon that is limited to Asia or South East Europe. It also takes place right on our doorstep," says Ingrid Bichelmeir-Böhn, leader of the Global Brand Protection Team at Schaeffler.

"The German and European markets are no longer only flooded with counterfeit luxury or consumer goods, there is also an increase in counterfeit industrial products that are relevant to safety such as rolling bearings".

The spindle bearings, spherical roller bearings, ball bearings and needle roller bearings scrapped during this operation are only part of the confiscated counterfeit products.

The majority were disposed of locally under the supervision of the relevant national authorities.

The counterfeiting of rolling bearings and the distribution of these products are consistently pursued by Schaeffler worldwide and may lead to prosecution in some cases. Not only is there the threat of claims under civil law for cease and desist orders, damages and the submission of counterfeit products for destruction, but also the threat of prosecution under criminal law in conjunction with a fine and/or imprisonment if necessary. The economic losses caused by counterfeit products are very difficult to estimate. In addition to lost sales proceeds and the damage to the company's image due to low-quality goods, high costs are incurred for the investigation, confiscation and correct disposal of bearings.

Not only are the companies that manufacture brand name products and conduct complex research, development and quality assurance damaged, but also the companies who install counterfeit parts and their customers. A current case from Switzerland proves once again that significant damage can be caused by the failure of a rolling bearing when it is a safety-relevant part in machines and facilities. Due to a customer complaint by a Swiss company, it became apparent that a counterfeit cylindrical roller bearing was fitted during the repair of a machine. Hot running occurred after only six months, despite regular maintenance. This was noticed in good time by the customer, however, it still resulted in repair costs of around 17,000 euros, which exceeded the value of the bearing many times.



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Company Name: _____
 Address: _____

 City: _____
 State/Province: _____ ZIP/Postal Code: _____
 Country: _____
 Telephone: _____ Fax: _____
 E-mail: _____
 Website: _____

4 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) _____

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

Corporate Management (1)
 Plant Engineering (2)
 Design Engineering (3)
 Marketing & Sales (4)
 Manufacturing Engineering (5)
 Purchasing (6)
 Quality Control (7)
 Factory Automation (8)
 Maintenance (9)
 Other (10) _____



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September 10–12—Essential Concepts of Bearing Technology. Duke University Conference Center, Durham, North Carolina. The American Bearing Manufacturers Association (ABMA) continuing education program will get attendees up to speed on bearing basics. This course will offer knowledge in rolling bearing types, bearing loads and applications, mounting methods, contact stresses, bearing load sharing, bearing pre-load, materials for ball and roller bearings, concepts in friction, ball and roller bearing deflections, failure modes and life standards. Attendees will receive a copy of *Rolling Bearing Analysis, Essentials Concepts of Bearing Technology, 5th Edition* as well as continuing education units upon successful completion of this course. For more information, visit www.americanbearing.com.

September 17–19—Gear Expo 2013. Indiana Convention Center, Indianapolis, Indiana. Gear Expo is a biennial event designed exclusively for the gear industry. For three days, gear buyers and manufacturers network and build relationships that benefit their respective companies. Attendees see firsthand the latest technology on the market and discuss trends in the industry with experts. Exhibitors have the opportunity to meet face-to-face with attendees and other exhibitors and will display more than 750,000 pounds of machinery on the show floor. Thousands of professionals from around the United States, international manufacturing hubs, and emerging markets conduct profitable business transactions and collaborate on the innovations that make their operations more streamlined. The ASM Heat Treating Society Conference and Exposition is co-located with Gear Expo 2013. For more information, visit www.gearexpo.com.

September 18–20—EPT-DA Annual Convention. Hilton Molino Stucky, Venice, Italy. EPTDA's annual conventions are highly acclaimed by PT/MC professionals as being a leading event in the industry, providing time- and cost-saving solutions for expanding business networks and enhancing knowledge. This professional industry summit is hosted annually, generally at the end of September, and is open to both members and non-members. Attendee benefits include a premier connection hub for global PT/MC distributors and manufacturers, an executive networking event gathering over 300 PT/MC key decision-makers, B2B meeting platform for distributors and manufacturers, an educational program featuring prominent business leaders as keynote speakers, local company visits and extensive opportunities to discuss business issues, best practices and innovative ideas both formally and informally. A diverse social program is available for partners and spouses during the event. For more information, visit www.eptda.org.

October 3–5—PTDA Industry Summit. J.W. Marriott Desert Springs, Palm Desert, California. The theme for this year's Industry Summit—"Working Without a Net?"—reflects how, despite all of the communications bombarding us daily, it takes collaboration to find the right information to move your company forward. Fortunately for those in the power transmission/motion control distribution channel, the PTDA Industry Summit offers a support net through the extensive opportunities to discuss business issues and develop innovative solutions. On average, more than 550 delegates—the industry's top executives representing 240 companies—will network and conduct business at this year's Industry Summit. In addition to being a cost-efficient and powerful connection hub, the emphasis on current events and economic trends can provide you with the net you need

to be more secure in your plans for your business moving into 2014 and beyond. Highlights include educational workshops, peer networking forums, one-on-one meetings and an optional golf outing benefiting the PTDA Foundation. For more information, visit www.ptda.org.

October 15–17—Motion Control 2013. Los Angeles Convention Center. Motion Control 2013 is a conference and pavilion at WESTEC 2013. This conference is focused on the latest trends and advancements in the design and operation of motion control systems and power electronics for manufacturing and industrial applications. Covering motors, drives, automation systems, power electronics, controls and system integration, the event includes best practices in designing motion control systems for ultimate output and performance utilizing the latest components and technologies the industry has to offer. Attendees will discover how new technologies are improving performance, energy efficiency and providing cost savings for OEMs and industrial operations. Design and system engineers with OEMs and R&D engineers will find solutions in electric motors and drive systems, semiconductor products, electronics, linear motion technology and motion systems for lean manufacturing and process control. For more information, visit www.motioncontrolexpo.com.

November 19–21—Fluid Power Systems Conference. Doubletree Hotel, Rosemont, Illinois. This educational conference will deliver hands-on instruction into practical maintenance techniques and offer roundtable discussions with industry peers. The Innovations Showcase will focus on the newest products and technologies in hydraulics and pneumatics. It is hosted by the International Fluid Power Society, the FPDA Motion and Control Network and the National Fluid Power Association. For more information, visit www.nfpa.com.



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For the Seabees, hazardous construction zones have always been part of the job

Do you know once the U.S. was in an officially declared state of war (December 1941) with Japan and Germany that, under international law, the use of civilian labor in war zones became illegal? (That's because civilian workers resisting enemy military attack were subject to summary execution as "guerrilla fighters.") Do you know during the D-Day invasion of Normandy that the Seabees were among the very first to hit the beach (as members of naval combat demolition units)? That in the teeth of relentless machine-gun fire, entire squads were decimated before reaching shore when enemy gunfire prematurely detonated their explosives?

Nevertheless, they were successful in opening holes in the enemy's stout defenses.

Do you know that Ward Cleaver was a Seabee?

Or maybe your introduction to the Seabees was the 1943 John Wayne film, *The Fighting Seabees*. According to various online sources the film is credited with helping to attract much-deserved attention to the valuable work done by the battalion.

The early history (www.seabeehf.org): The first Seabees were seasoned enough — if asked — not to go looking for any left-handed monkey wrenches,



Builder 3rd Class Joseph Flowers, assigned to the Naval Mobile Construction Battalion (NMCB) 15's Convoy Security Element, throws chains under a pallet of sandbags while constructing a bunker in support of the Afghanistan National Army. (U.S. Navy photo by Mass Communication Specialist 2nd Class Daniel Garas/Released)

as the emphasis in recruiting them was placed on work experience and skills. But to find recruits with the necessary qualifications, physical standards were relaxed in comparison with the other branches of the military. And in illustration of early wartime patriotism, it was discovered that several men past 60 had managed to join up, although the age range for enlistment was 18-50. Indeed, during those first uncertain days of the war the average age of a Seabee was 37. But early in 1943 voluntary enlistments were halted by President Roosevelt and men for the construction battalions had to be processed through the Selective Service System. The result: Seabees were now of a much younger average age, but they joined the group lacking the necessary skills.

The exploits of the Seabees — young and "old" — in wartime leave us with much to be grateful for. But things change—and so over the years have the Seabees. Early on, beginning with their formation in 1942 as a "militarized, U.S. Naval Construction Battalion" — or CBs — they were known primarily for their demolition, road and airstrip construction prowess. But the Seabee of today is someone proficient in any number of engineering sectors and applications, often working as certified mechanics in, for example, power plants or as mechanics for aircraft; diesel; refrigeration; electronics; hydroelectric machinery; and electric motors.

If there's a problem with gearing or electricals, today's Seabees are trained to fix it. And isn't that a good thing when you consider all the U.S. companies looking for competent people to do the very same

"We Build, We Fight"

Seabees motto

thing? After all, most Seabees aren't military lifers; after their discharge they will be looking for good-paying work in the field they were trained for.

So there you go — hire a Seabee!

Consider: condition monitoring is the manufacturing buzz term du jour, correct? Now take a look at the areas a typical Seabee is trained up for as a *certified* construction mechanic: diagnose and troubleshoot equipment failures; repair and maintain diesel and gasoline engines; adjust and repair ignition, fuel, electrical, hydraulic and steering systems; work with hoisting and jacking equipment, power tools, measuring instruments, gauges and meters; lubricating equipment; maintain and repair tires, batteries, brakes and valves; and perform shop management functions such as maintenance scheduling and spare parts inventory control.

If I'm an OEM, job shop, or just about any other hirer of manufacturing personnel, I'm going to be doing some reverse recruiting of Navy Seabee veterans. And, they are combat-ready with no background check needed.

Consider this as well: Seabees earned 33 Silver Stars and 5 Navy Crosses during World War II; 272 enlisted men and 18 officers were killed in combat. More than 500 Seabees died in *construction accidents*. In addition to the European theater, the Seabees were at Saipan, Guadalcanal, Tarawa, Anzio, and much, much more throughout the Pacific. At war's end 325,000 men had enlisted in the Seabees, representing dozens of skilled trades.

Since WW II, the Seabees have been a vital part of every major U.S. military action — from Korea to Afghanistan. That is quite a resume, a resume that continues to evolve right along with advancing technology.

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