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Embracing Change

Change can be daunting, nerve-wracking or even downright scary. But when we’re faced with change in our lives, it’s not the change itself we fear. It’s the unknown elements that come with it.

“You don’t know what you don’t know,” a wise man once told me.

He wasn’t advising me to accept my ignorance. Rather, he was challenging me to continue learning. Knowledge, after all, is how you overcome the fear associated with change. Understanding all those unknown elements helps you figure out whether to run and hide, stand and fight or watch from the sidelines.

Nowhere is fear of change more clear than when we’re faced with new technology, which continues to evolve in ways we never expected — even in mundane fields like mechanical power transmission. When that change has the potential to disrupt or even threaten our business, fear is natural. But when you attack the unknowns, you begin to see how that change might offer benefits and opportunity in addition to its challenges.

I’ve just returned from the SPS trade show in Nuremberg, Germany, where I had the opportunity to visit with many suppliers of gear drives, motors, bearings, couplings and other mechanical power transmission products. Although the company names are familiar, most of them are no longer the traditional component suppliers you remember. They’re evolving with and creating new technology, embedding sensors in their equipment, connecting motion devices to the cloud, and embracing technology. Most of these companies no longer see themselves as providers of components. They see themselves as providers of systems and solutions. You don’t really need a gear drive, after all. What you need is so much torque and speed, and the ability to control it.

I learned from R+W about how sensors are being integrated into components to create intelligent couplings. I learned from Schaeffler about the ways plant maintenance is becoming simpler, more robust and better connected through the use of smart components and systems. I saw how NORD has developed an app for monitoring gear drives in industries like agriculture, mining and more. I also saw how Warner Electric is providing contactless monitoring solutions for electric clutches and brakes to create machine intelligence at the component level. I saw a lot more, too, and it all has to do with technology — and change. Stay tuned to these pages, because these and many other stories from SPS will be told in detail over the coming months. We’re committed to bringing you the knowledge you need to navigate the technology so you can embrace the changes as they come.

You may have heard, but here at Power Transmission Engineering, we’re in the midst of some significant change ourselves. Effective January 1, 2020, Power Transmission Engineering, along with our sister publication, Gear Technology, will become part of the American Gear Manufacturers Association.

Michael Goldstein (that wise man I mentioned earlier) founded Gear Technology in 1984, and we began publishing Power Transmission Engineering in 2007. When Michael began to think about retirement, he didn’t just want to sell the magazines. Instead, he wanted to find a permanent home for our publications that had a similar focus on high-quality technical content, education and service to the industry. Over 35+ years, Michael has instilled those values in us, and I’m confident that the tradition will continue under AGMA.

Besides adding our publications, AGMA is undergoing a transformation in other ways, too, with an eye toward the future and an attitude that embraces change and looks for opportunities for its members and the industry. Their trade show, Gear Expo, became the Motion+Power Technology Expo in 2019. They have a robust emerging technologies initiative, and they’ve recently become the managers of the American Bearing Manufacturers Association. The association’s goal is to be at the center of innovation for power transmission technology.

And that’s a pretty good place for us to be, too.

Our transition should be a smooth and easy one. Michael Goldstein will continue providing wisdom in a consulting role over the next year. The rest of our staff will remain the same, and we don’t expect you’ll notice any difference with regard to the content in our magazines and on our websites. In fact, if anything, we hope you’ll notice that we’re more closely engaged with the industry than ever. We plan to take full advantage of the connections and insights that our new relationship with AGMA affords, and that should only help to make our content better.

All that considered, we’re embracing the change. We hope you do, too.

Randy Stott, Managing Editor
THE COUPLING.
FOR THE HIGHEST LEVEL
OF PRECISION

BELLOWS COUPLINGS

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Recently, the Swedish rolling bearing manufacturer SKF and the Swiss gearbox design software developer KISSsoft have incorporated SKF’s bearing calculation service within KISSsoft’s software. With the so-called ‘SKF Bearing Module’ in KISSsoft, engineers will have direct access to SKF’s bearing technology and bearing performance data. This connection allows for a seamless experience when working on a new gearbox design. Without noticing, an engineer designs a gearbox in KISSsoft ‘as usual’, but is actually connecting to the SKF cloud to retrieve the bearing performance results. These results are based on extremely fast, cloud-based calculation services by SKF in which the operating conditions of the full system are considered when calculating the performance of each individual bearing. As such, a gearbox design is verified more realistically and efficiently as it enables making appropriate bearing choices right from the start.

The user flow is quite simple: First, the user creates a full (gearbox) model in KISSsoft. Then, after registering once for the SKF Bearing Module (using the embedded “SKF Registration Tool”), SKF’s calculation service is called, whenever the bearing performance is calculated according to the modified rating life method according ISO 281. This method can be selected in KISSsoft in the ‘basic data’ window of the bearing and is mandatory if the effects of lubrication and contamination are to be considered.

**Modified rating life according ISO 281**

If the modified rating life option is not selected, the ISO 281 basic rating life (L₁₀, here referred to as ‘basic ISO 281’) of the bearing is calculated which accounts for the load and speed only. For modern high-quality bearings, the calculated basic rating life can deviate significantly from the actual service life in a given application. Service life in a particular application depends not only on load and bearing size, but also on a variety of influencing factors including lubrication, degree of contamination, proper mounting and other environmental conditions. The ISO 281:2007 modified rating life method (L₁₀₅₀, here referred to as ‘modified ISO 281’) uses a modified life factor (aISO) to supplement the basic rating life. Similarly, for “SKF Rating Life”, the life modification factor aSKF applies the same concept of a fatigue load limit Pu as used in modified ISO 281. Just as in modified ISO 281, to reflect three of the important operating conditions, the life modification factor aSKF takes the lubrication conditions, the load level in relation to the bearing fatigue load limit, and a factor ηₙ for the contamination level into consideration.

**SKF Rating Life instead of modified ISO 281**

The modified rating life according to ISO 281, considering lubrication and contamination conditions, can also be calculated without activating the SKF Bearing Module in KISSsoft. This ISO method may be necessary to use for design certification purposes, however it is not necessarily the most reliable method for bearing performance prediction. One can actually say that the SKF Rating Life is an enhanced version of modified ISO 281, where latest findings of tribology and materials in rolling bearings are taken into account. The difference between the two methods is in the calculation of the life modification factor (aISO vs aSKF) which can have a significant effect on calculated bearing rating life.
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SKF Rating Life for an SKF Explorer bearing

The difference between SKF Rating Life and ISO 281 modified rating life is most significant for the SKF Explorer bearings. SKF Explorer rolling bearings accommodate higher load levels and provide extended service life. Their optimized internal geometry reduces friction, wear and heat generation, allowing heavier loads to be accommodated. Moreover, advanced surface finish reduces friction and enhances lubricating conditions.

SKF Rating Life fully accounts for the benefits of SKF Explorer bearings whereas they are only partly accounted for in the modified ISO 281 method. To fully utilize the improved performance of this bearing performance class, and therewith optimizing machine performance, the SKF Rating Life calculation by the SKF Bearing Module is needed. The two different life method results will both be displayed in a KISSsoft report and can thus be easily compared.

Benefits of SKF Bearing Module.

Always connected to the latest bearing design

With the bearing module, a direct connection is established to SKF’s core proprietary knowledge, the bearing internal geometry and manufacturing data. Only SKF has the full (internal) geometry description of the products they manufacture. Not all this data will be revealed to the user but its effect on bearing performance will always be accounted for in the calculation. Design and manufacturing updates as well as bearing assortment changes will be reflected almost instantly as the cloud-based service is constantly receiving updates from the bearing database. This gives the user access to the latest assortment with up-to-date geometry data, independent from the (static) bearing database in KISSsoft itself.

Bearing performance parameters

The Bearing Module performs the calculation of the following bearing performance results: SKF rating life (L₁₀m), ISO 281 basic rating life (L₁₀), equivalent dynamic bearing load (P), load ratio C/P, viscosity ratio (κ), contamination factor (ηC) and the life modification factor (αSKF). These output parameters are all related to bearing load and rating life under the applied operating conditions of the system.

The development of the Bearing Module does not end here, in fact more bearing performance parameters will be added in future versions of the module. Hereby one can think of bearing friction and power loss, grease life and grease re-lubrication interval, static safety, bearing excitation frequencies, etc. In additional to the technical evaluation, a design engineer can already from the beginning make a choice of selecting within so-called ‘Popular items’, i.e. bearing items that have a high availability level and thus provide an especially attractive cost-performance ratio.

The SKF Bearing Module is a fast and modern cloud service, easily accessible to design engineers and therefore step by step one will have access to the complete play-field of bearing engineering technology.

Comparison of results from SKF Bearing Module and ISO 281 calculation methods in the KISSsoft report.
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**SKF’s new life method (GBLM)**

Up-to-now, none of the common bearing rating life models, neither the ISO life models nor SKF Rating Life or more advanced methods, were able to fully quantify the benefit of hybrid bearings. Hybrid bearings have rings made of bearing steel and rolling elements made of bearing grade silicon nitride, which make the bearings electrically insulating. They can extend bearing service life by offering enhanced bearing performance, even under difficult operating conditions.

Based on the substantial progress made in the surface life modelling area, SKF has successfully integrated this knowledge into a new rolling bearing rating life calculation, called the SKF Generalized Bearing Life Model (GBLM), which currently is used for hybrid bearings only. This model effectively separates surface failure modes from sub-surface failure modes and therefore can capture in a better way the performance of hybrid bearings, which usually perform better in harsh lubrication and contaminated conditions or at high speeds. However, due to their higher stiffness, hybrid bearing can concentrate higher sub-surface stresses in high load conditions. GBLM is able to represent this behaviour well and is also accessible through the SKF Bearing Module in KISSsoft.

The KISSsoft Release 2019 offers the possibility to calculate bearing performance by SKF through a cloud calculation service. Bearing rating life and other performance parameters are calculated based on direct access to SKF bearing geometry data and SKF formulas which have been validated by extensive testing at SKF facilities. The results are separately displayed in KISSsoft, but can quickly be compared with ISO results. With the SKF bearing module in KISSsoft, a machine designer gets right into the heart of SKF, the world leading bearing supplier. As a result, the prediction of bearing performance becomes more realistic, especially for the SKF Explorer range and hybrid bearings.

For more info, please send an e-mail to skfbearingmodule@skf.com or info@kisssoft.ag.
Merry Christmas
And May Your 2020 Be Pawsitively Gearlightful!

From: Our Family
To: Yours

Our sincerest thanks to everyone who keeps Forest City Gear spinning smoothly.

Joe

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Eaton
ANNOUNCES 4-SPEED TRANSMISSION FOR ELECTRIC COMMERCIAL VEHICLES

Eaton recently announced its eMobility business will launch an all-new 4-speed transmission for heavy-duty electric commercial vehicles to meet growing demand in a number of segments, including pickup and delivery and port drayage in North America, China and Europe.

The new transmission, designed for Class 7 and 8 commercial vehicles, is currently in the testing phase with major OEMs and is set to debut in 2022. The announcement was made at the North American Commercial Vehicle Show (NACV) in Atlanta, Georgia, USA.

The transmission is the latest addition to Eaton’s growing eMobility portfolio of electrified vehicle (EV) transmissions and other componentry, which also includes medium-duty 2- and 4-speed models that are also currently in production with several OEMs.

“Electric buses and trucks need to be able to go up hills and run at highway speeds when they are fully loaded,” said Scott Adams, senior vice president, eMobility, Eaton. “Our solution is to expand the range of the motor by adding an EV transmission. With this addition, the vehicle can perform well on hills and efficiently at highway speeds with a smaller, less costly motor.”

The heavy-duty 4-speed EV transmission solves the primary issue related to single-speed drives: contradictory requirements for high efficiency at top speeds and increased torque at launch and low speeds. Fine-pitch helical gears ensure a smooth, low-noise operation, while the Eaton Transmission Control Unit’s shifting strategy is designed for fast gear changes and maximum efficiency, which extend range and battery life.

The transmission is based on traditional, robust and efficient lay shaft architecture typical of AMTs but is designed specifically for electric commercial vehicle applications. Unlike traditional commercial vehicle transmissions, Eaton’s 4-speed EV gearbox does not have a clutch, and shifts are synchronized using the traction motor. It also operates at higher speeds than its traditional internal combustion gearbox counterparts, and gears are optimized for electric motor performance.

By providing higher output speed capability and torque range than a direct-drive system, the transmission enables the usage of a smaller, lighter electric motor for large commercial vehicles.

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- Metal Processing Systems: Schmidt Offset Couplings connect to nip rolls for accurately feeding steel web material for processing. They open easily for threading in new material and allow for different material thicknesses. They allow downforce on a nip roll while isolating the downforce from the connecting motor/gearbox. They are a good choice for uncoilers, coil straighteners and roll forming systems among other types of metal processing equipment.
- Automated Assembly Systems: Schmidt Offset Couplings open up many new possible applications for automated systems including packaging, pharmaceutical, food processing and much more. Their unique design allows for critical machine space savings on production floors.

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KISSsoft EXAMINES E-MOBILITY APPLICATIONS

The increasing number of electric vehicles is already having an impact on the design of transmissions. Although the number of gears in e-mobility applications is typically lower than in conventional passenger cars, the requirements for low-noise and low-vibration transmissions as well as high power density and transmission efficiency are very high. For the engineer, this means a whole series of new challenges.

KISSsoft offers various calculation modules for the design and optimization of vehicle transmissions. With the help of KISSsys (modules SYS, ZPK and WPK), the entire gearbox kinematics can be set up quickly and easily along with a strength evaluation of the overall system. Rough sizing (module ZA3) and fine sizing (module ZA4) allow basic dimensioning and macro-geometry optimization of cylindrical gears. The contact analysis under load (modules ZA30, ZA33 and ZA35) enables both a specific design of flank line contact and consideration of the load distribution between the gears.
corrections for an optimized loaded tooth contact as well as the design of profile corrections for lower noise excitation and high efficiency.

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The ABB Ability Digital Powertrain concept has now been extended to cover Dodge gear reducers fitted with the smart sensor for mechanical products. The Digital Powertrain enables real-time health monitoring of all the critical elements in industrial processes, such as drives, motors, pumps, bearings and gearing. Immediate access to this key data enables operators to maintain optimal conditions for maximum productivity and safety.

“The capability for remote monitoring of temperature and vibration data across multiple assets within the digital powertrain enables maintenance teams to build a complete picture of the overall health of their equipment,” says Artur Rdzanek, product manager for sensor technologies, Dodge mechanical products at ABB.

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When it comes to specifying linear motion within a machine, system designers have many options from which to choose. Making the right choice can impact the ease of installation, footprint and cost of operation. A common driving mechanism for achieving linear motion is a stepper motor and externally supported lead screw-based assembly. A simpler, easier-to-install approach, however, is to select a drive mechanism with built-in guidance and support, thus removing the need for external components that would normally perform these functions and the complexity that comes with them.

Obtaining linear motion the traditional way
The core components of a traditional stepper motor and lead screw-based driving mechanism are the following:
- Stepper motor
- Motor to lead screw coupler
- Lead screw
- Lead nut

For this core to support a load and induce motion, however, additional components are required, including, for example, radial bearings and bearing mounts, linear bearings and guides, and mounting plates for all components. (Figure 1)

In these traditional mechanisms, powering on the motor usually produces motion by rotating the motor shaft that is coupled to a lead screw, causing it to rotate as well. The rotating lead screw then engages the lead nut that is attached to the load, and if it is properly supported and guided as shown in Figure 1, the nut and load translate axially across the lead screw.

Downside of external guidance and supports
While external assemblies can secure the nut effectively, there are drawbacks to this design approach. Primarily, the high component count contributes to a longer and more complex installation process. Installation is a challenge when utilizing external supports and guides because it is absolutely critical to ensure alignment is nearly perfect between all mating components. For proper motion to occur, all corresponding components will need to be carefully and properly positioned and secured. For example, if the lead screw and linear guides are not parallel with one another in both axes, there is a high likelihood of binding occurring, causing the entire drive mechanism to stall out.

In addition to a tedious and time-consuming installation process, prior to installation, a proper sizing and selection exercise to select the appropriate external guides and supports must be completed. Undersizing guides and supports can lead to premature failure of the entire mechanism, and oversizing can bring a significant increase in overall assembly cost and weight.

A third potential drawback of utilizing external guidance and supports is that the lead screw, lead nut, linear bearings and guides are completely exposed to the environment, which introduces the risk of contamination. Whether it is to prevent outside contaminants from penetrating the surfaces of the lead screw/lead nut and causing excess friction or to protect from wear debris generated by the sliding nut and leaking out in the overall system, a proper barrier is important.
A simplified solution

Designers of applications requiring shorter strokes with minimal radial and moment loads can avoid the drawbacks of the lead screw-based assemblies by choosing motorized lead screw actuator (MLA) -based drive mechanisms that integrate the guidance and support directly within itself. (Figure 2) This design choice completely eliminates the need for cumbersome external guidance and support.

MLAs enforce guidance by utilizing a splined cover tube that completely captures the mating lead nut and prevents rotation, while allowing axial translation. The integrated linear sleeve bushing within the end-cap at the front of the cover tube provides radial and moment load support.

A configuration like this offers many potential benefits to both the design engineer and the machine builder. As mentioned above, integrating support and guidance directly into the MLA unit significantly reduces complexity and time of installation. Instead of having to install and tediously align external guides and supports with the drive mechanism, a simple MLA can be utilized.

Also, if particulate contamination is of concern, use of an actuator eliminates the need for an outside protective barrier because the MLA unit has the lead screw, lead nut, guide and support completely housed within the cover tube.

Figure 2  Motorized lead screw actuator (MLA) with integrated linear guidance and support.
Comparing traditional and MLA configurations in two sample applications

If the conditions are right, MLAs can be a simple and elegant driving mechanism for linear motion assemblies. The following sections highlight ideal applications where MLAs can offer a considerable benefit.

Comparing drive options for medical fluid pumping

In a medical or laboratory environment, fluid pumps are commonly used to accurately deliver fluids into a patient’s body or test tubes for mixing or analysis. This fluid is usually expelled from a syringe reservoir by actuating a piston attached to a linear drive mechanism. Although not optimal, a traditional stepper motor and lead screw-based drive mechanism with external guidance and supports can accomplish this movement (Figure 3a).

However, since fluid pumps must often fit within space-constricted areas, minimizing components and shrinking the drive mechanism’s footprint can be of great value. MLAs improve fluid pumping in such applications by removing the need for external guides and supports that could consume valuable real estate within the machine where the pump is placed (Figure 3b). As MLAs have a completely self-contained guidance and support, the component count and simplicity of the fluid pump assembly can be dramatically improved. (Table 1)

Furthermore, because fluid pumps are used primarily in hygienic areas, the sealed enclosures of the MLAs prevent contamination from either entering or leaving the system.

Comparing Drive Options for Liquid Handling and Pipetting

A liquid handler is a multipurpose machine intended to sample, mix and combine liquid samples automatically. Fully automated workflows simplify repetitive fluid dispensing tasks. These operations require a pipette to dispense fluids into sample locations such as test tubes. The motion often requires complex guidance and support structure. (Figure 4a)

For such applications, designers prefer simpler and more compact drive mechanisms, which an MLA can provide. The pipetting motion itself is rather simple, and the loads tend to be very light, making it an ideal candidate for an MLA drive

Table 1  Comparing stepper motor lead screw integration options for fluid pumping

<table>
<thead>
<tr>
<th></th>
<th>Traditional stepper motor lead screw integration option</th>
<th>MLA option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total component count</td>
<td>25+</td>
<td>2</td>
</tr>
<tr>
<td>Approximate installation time (minutes)</td>
<td>90+</td>
<td>5</td>
</tr>
</tbody>
</table>

More than 25 total components required for full guidance and support

Guidance and support directly integrated into MLA unit

Figure 3a  Fluid pump utilizing a traditional integrated stepper motor and lead screw-based drive mechanism with external guides and support.

Figure 3b  Fluid pump utilizing an MLA as the drive mechanism.

Figure 4a  Traditional stepper motor lead screw requires a profile rail guide and corresponding carriage assembly to translate axial motion.

Figure 4b  MLA assembly eliminates the need for external guidance and support.
mechanism. And because the guidance and support are directly integrated within the MLA unit, the need for external guidance and support components is eliminated, thus reducing the component count and dramatically simplifying the pipetting sub-assembly. (Table 2) The enclosed system of the MLA is also well-suited to the purity of the laboratory environment.

**Selecting the right drive mechanism**

In addition to fluid pumping and liquid handling, other applications in which MLAs offer advantages can include vertical plate or surface adjustment, pipetting, microscope slide positioning, proportional valve control and monitor/screen tilting. Considering the following factors will help determine whether an MLA option would be a good fit for a specific application.

**Motion parameters**

MLAs are most suitable for applications requiring strokes of less than 2.5 inches (63 mm); moderate loads (up to 200 lbf or 90 kgf for larger motors), and speeds from approximately 0.5 in/s (13 mm/s) for low leads to approximately 8 in/s (200 mm/s) for higher leads.

**Side and moment load handling**

While most stepper motor and lead screw-based drive mechanisms can handle considerable axial load, if side and moment loads are present, guidance and support from linear bearings, guides and supports will be required. However, if the side and moment loads are light enough — up to approximately 10% of axial load capacity of the motor — the integrated guidance and support design of an MLA is sufficient.

**Simplicity**

If reducing component count and simplifying are priorities, designers can benefit from a fully integrated MLA configuration, removing the need for complex external guidance and support components.

**Installation**

Reducing component count simplifies installation, dramatically shortening total assembly time. Instead of having to mount external linear guides, linear bearings and mounts, and having to carefully align them, installers can simply mount a single MLA unit that has all guidance and support directly integrated within the unit. MLAs traditionally come with a standard NEMA motor bolt hole mounting pattern, making them easy to install as a near drop-in replacement to previous stepper motor-based drive mechanisms.

<table>
<thead>
<tr>
<th></th>
<th>Traditional stepper motor lead screw integration option</th>
<th>Motorized lead screw actuator (MLA) option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total component count</td>
<td>30+</td>
<td>8</td>
</tr>
<tr>
<td>Approximate installation time (minutes)</td>
<td>120+</td>
<td>5</td>
</tr>
</tbody>
</table>
Environmental
Systems used in hospitals, laboratories, clean rooms and other settings where contamination is of concern also benefit greatly from the sealed, all-in-one, unit.

Customization
If none of the available offerings meet your needs, you may consider working with your vendor to create a custom option that does. Most vendors offer options to customize motor windings, encoders, cabling and connectors, end mounting, linear travel per step, and stroke lengths.

An overall simpler solution
MLAs may not be suitable for all applications. However, for those with the right motion parameters, side and moment load handling needs, simplicity preferences, and installation requirements, specifying MLAs brings numerous benefits for designers. Instead of having to design the external guidance and support assembly, they can specify a single drive unit with anti-rotational guidance and support built in. This solution would reduce double-digit component counts down to a single part number. Alternatively, with multiple, externally integrated components, there is a greater risk for system failure and extended process downtime, while parts are located and repairs made. Having only a single component to deal with, chances of failure are lower and the time required for repair is shorter.

Another benefit of MLA technology is reduction in installation time from over an hour to mere minutes, which decreases associated labor costs. Because there is only one primary part, it saves the time needed to size and align multiple components necessary in an equivalent system. Finally, being enclosed, this type of product is packaged to provide improved environmental protection — thus sealing the deal on a better solution for your application.

For more information visit MotionIndustries.com/pte, or view the MiHow2 video, “How to Install and Align a Ball Screw Assembly and Profile Rail” (https://tinyurl.com/y5wproem).

Julian Anton is Design Engineer, Thomson Industries, Inc., and is responsible for new product design and development for lead screws and stepper motor linear actuators. He earned his Bachelor of Science in Mechanical Engineering from San José State University. Anton has been with Thomson for 6 years.

Chris Diak is the Automation Product Sales Manager at Motion Industries and has worked in the electrical/automation field for 24 years, with the last 22 at Motion. He earned a Bachelor of Science in Electrical Engineering from Clemson University.
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ANCA Explores Hiring for the Factory of the Future

SIMON RICHARDSON, ANCA PRODUCT MANAGER, ANCA

In the factory of the future, technology will of course be key. Factories will integrate networked machines, sensors and advanced robotics IT systems into existing processes. They will thrive on data, real-time figures and unprecedented access to information to be more efficient, less wasteful and better connected. As your operations are transformed, you will need a workforce that knows how to take your business into the future time and time again. This means rethinking how your hire, and how you upskill existing staff. This doesn’t have to mean starting from scratch. You may be well on your way to a great future workforce already.

The skills you need are changing

You may already be using technology to move forward. As factories shift to a future focus, they are adapting what’s already available — like the cloud, robotics and in-process measurement. This brings new skill requirements. Knowing how to use these tools to their full potential means having a team of critical thinkers. The FoF will require a workforce that’s computer savvy and driven by problem solving. Staff will need to be analytical, knowing how to use data to continuously improve. Teams should incorporate good software development skills and programmable logic controls experience. You will need people who can network machines and those who are able to capitalize on the immense value of automation. With the speed of the tooling industry increasing, they will need to become their own innovation hub, constantly looking for opportunities to grow and improve through technology.

How to hire for the factory of the future

People working in factories of the future will need to be more fluid. They will have to think cross-functionally and collaborate to make the most of their complementary skills. Much like a software programming team, these workforces will need an agile mindset, be open to new approaches and ready to adapt to work better, harder, smarter. Finding and hiring these people will mean understanding what’s involved in their different roles. You will likely find you need to fill a mix of existing and new positions, some of which you might not have come across before. Look for staff with a STEM — science, technology, engineering and mathematics — background — they are more and more likely to be university graduates. But their education should only be a starting point. Look for applicants who demonstrate lateral thinking and problem-solving skills, signals that they can put their technical background into practical use. Existing roles are evolving. Machinist skills such as operation monitoring, systems evaluation and quality control analysis can be applied to new systems. Tool and die makers can use their technology design and operations analysis background to build better processes and create new tools. New roles will also appear: robotics engineers, automation engineers, and roles that combine elements of both. Positions will also be created for people to bring new ideas into the business. Factories may start hiring senior IT staff such as a CTO or CIO. These tech leaders will become champions of innovation — sourcing, internally promoting and working to imple-
ment the very best for the factory. In such a new field, having their authority on hand to assist with interviews can be a game-changer. Senior tech staff will have the right knowledge to spot candidates who can apply their expertise to your business. You may also be able to leverage specialized recruitment agencies that can make sure you’re only interviewing people who can bring the right combination of technical nous and creativity.

**When you’ve got the right team — nurture it**

In the factory of the future the focus is shifting from working the production line to building a better one. Automation and robotics have changed the way the factory floor looks, and those changes will keep coming. Just as with technology, setting yourself up with the right people doesn’t have to mean starting all over again. As long as you have clarity around where you’re going and how, you will give yourself the best chance to identify potential in your existing workforce. Factor in training. Most businesses will need a training officer, not only to train staff on the existing production methods but to bring them on board with new operations. Support your people to work together. A collaborative, agile approach should apply across the whole business, from learning how to use existing equipment to working together to implement new products. A team of champions will work side-by-side to make sure every element of operation is adding value and working to its full capability. Engage your staff. Use your trainers and tech champions to communicate the vision and future of the factory. Motivate them to feel excited about the future by offering clarity and direction. With competition increasing, the most important thing in the factory of the future is to retain skilled people. The next generation is demonstrating more of these diverse, flexible skills, but increasing demand means there is a global skills shortage. Finding and keeping good staff will make your workforce more efficient and save on hiring and training costs. Giving staff members opportunities to try out new tasks, upskill in their existing roles, undertake further education and create ownership of the factory’s direction will all help to strengthen their loyalty to the business.

**Give your team the tools to perform**

Having the best brains in the business won’t mean anything without the best tools. A team with great problem-solving skills can work together with machine manufacturers to create custom systems for the best output. The combination of analytical minds and high-level engineering means a flexible, adaptable system with endless potential. Supported by internal champions, new products can be implemented with enthusiasm and real buy-in from your workforce. That means continuous improvement with a loyal team as your factory moves ever further into the future. (wwwanca.com)

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ETEL Offers IL+ Motors for Electronics and Semiconductor Manufacturing

Etel, a direct drive motor manufacturer of the Heidenhain Group, now offers updated ironless linear motors optimized for electronics and semiconductor manufacturing. Called the IL+ product lines, these motors are offered in the same profile as Etel’s previously established ironless linear motors but now specially re-designed to allow for increased performance to benefit these two industries.

Unique to the IL+, a change in material selection now allows the Etel ironless motors to operate up to 600 VDC and reach a temperature limit up to 130°C, as opposed to the previous market standard of 300VDC and 80°C. This allows an increase in overall speed along with a greater force operating range. Track sizes are available in increments of 128, 256, and 512 mm.

Compared to the previous models, the IL+ series offers up to 20 percent temperature reduction at the same working point, reducing thermal expansion in both the glider and Magway as well as lowering any reduction in precision. The improvement of the forced air-cooling option now available on all sizes also allows an increase in continuous force by a factor of two.

Along with a new improved cooling option and other updates, the Etel IL+ ironless linear motors are available in two size ranges: the ILF+ focusses on smaller scale operations with a reduced size and length, while the ILM+ targets higher force operations with a greater variety of lengths. Both contribute to high precision and throughput during the electronics and semiconductor manufacturing processes.

The IL+ ironless linear motors are small size motors perfectly suited for very high dynamic and low moving mass applications. In addition, the total absence of force ripple ensures perfect speed stability and makes IL+ suited for scanning applications where speed control is a key specification.

The ILM+ ironless linear motors are a more powerful version of the ILF+ motors. The ILM+ series combine all advantages of ironless motors and provides high continuous force. This motor family is suited for the most demanding mid- to high-mass scanning applications where zero attraction forces and outstanding speed stability are required. The low mass per force ratio also makes ILM+ suited for very high dynamic applications. (www.heidenhain.us)

Intellidrives Expands Large Open Center Stage Series

The demand for a high accuracy, robust, open-frame stages is met with Intellidrives dual-axis, large aperture stages that address the unique needs of scanning microscopy, wafer and printed circuit board inspection, automated assembly and wide range of specimens and samples scanning in many types of imaging techniques and applications.

Very precise fine positioning and control is easily achieved through the combination of a stable closed-loop
control system and an associated joystick option. In addition, the stages can be combined with the company’s Z Stages to form an XYZ stage ideally suited for laser scanning microscopy. These stages can be motorized with stepper motors and brush-less servo motors with encoders. Optional high-resolution, non-contact linear encoder is available. This non-contact encoder offers exceptional repeatability and stability over a range of operating conditions. Both digital and analog output versions are available with resolutions in sub-micron range. (www.intellidrives.com)

H2W Technologies Introduces Single-Piece Extrusion Stage

The DRS-206-05-012-01-EX dual rail positioning stage is ideal for applications that require long travel distances. It uses a cog-free brushless linear motor to generate a continuous force of 12.4lbs [55.6N] and a peak force of 37.4lbs [167N] with a total stroke length of 210 in. [5341 mm]. The non-contact 1.0-micron resolution encoder allows for precise positioning. The stage is capable of speeds in excess of 200 ips [5 m/s]. It is guided by dual rigid recirculating ball linear bearings. The entire stage is assembled on a single piece of aluminum extrusion, thus reducing the overall weight of the system and easily allowing for long strokes and prevents the need for reassembly at the customer facility. There are also provisions that allow customer cables to be routed within the cable carrier. It has end-of-travel rubber bumper stops. (www.h2wtech.com)
Precision Drive Systems Hires Midwest Regional Sales Manager

Precision Drive Systems (PDS), a global provider of precision motor spindle support and repair based near Charlotte in Bessemer City, NC, has announced that it has hired Tom Kessler as its Midwest Regional Sales Manager to support US metalworking manufacturers.

“We are happy to welcome Tom Kessler to PDS as our new Midwest Regional Sales Manager,” said Allen Turk, CEO of PDS. “Prior to joining PDS, Tom dedicated 22 years to working in the industrial services industry. We look forward to adding Tom’s extensive experience to the spindle repair services we offer.”

As Midwest Regional Sales Manager, Kessler will work out of southeast Michigan to serve PDS’ metalworking customers throughout the region.

Kessler began his industrial career with Applied Industrial Technologies as a Service Center Manager and was then promoted to Linear Component Center Manager where he created the company’s state-of-the-art linear-motion service center in Detroit, Michigan. He was then hired by SKF to create their own linear-motion service center from scratch to establish a more competitive North American presence. Kessler spent a total of 17 years with SKF where he served in various roles including Program Manager, Product Specialist and Territory Manager. Throughout his career, he has worked with both OEM and MRO distributors and end-users in a variety of industries. (expertspins- dlerepair.com)

Igus Introduces Linear Robots for Cost-Effective Automation

Simple, precise, fast processes: these are the requirements of Cartesian robots. They are used for such things as pick-and-place applications, sorting systems and medical technology. Igus has now developed a linear and room linear robot for large workspaces. The two new kinematics systems allow users to move up to five kilograms. Both linear robots are available directly from stock. They can also be customized to suit the customer application in question — no minimum order quantity.

To survive on the market, both large industrial players and small companies need automated solutions that will quickly pay for themselves. For years, Cartesian robots have
Bosch Rexroth Offers New Motion and Automation Software Tools

Nowadays, mechanical engineering is software development. The new ctrlX Automation platform is Bosch Rexroth’s answer to this market requirement. It encompasses the latest engineering software technologies and all PLC and motion tasks. Software functions are combinable in any number of ways with ready-made, customized and customizable apps. These apps can be created in a variety of programming languages such as C++, script languages such as Python, or new graphical languages such as Blockly. This gives machine manufacturers new-found freedom.

This system offers users a choice: they decide whether to program in IEC 61131, PLCopen or G-Code, or in conventional high-level or Internet languages. This liberates machine manufacturers from dependency on the availability of PLC specialists and proprietary systems.

Configuration and commissioning of the automation components is completely web-based, eliminating the need to install software. Within minutes of switching the system on, the software is programmed. A completely virtual ctrlX Automation system environment is available, enabling programming without hardware. System functionalities can be extended at any time via the user’s own process functions, apps, and open source software. In total, ctrlX Automation cuts the engineering time and effort by 30 to 50%, which significantly reduces time to market for new machines.

More than 30 direct connection options and communication standards offer maximum networking flexibility for economical end-to-end connectivity from field level up to the cloud. ctrlX Automation is also equipped for future communication standards such as TSN and 5G, making it the best system on the market in terms of networking capability. ctrlX Automation is based on a new generation of multicore processors which provide sufficient processing power for almost all automation tasks. These high-performance CPUs can be integrated into embedded PCs and industrial PCs or directly into drives. The all-new hardware and software module will cover all automation tasks—from simple control applications and IoT solutions to high-performance motion control. (www.boscrexroth.com) PTE

been a means of choice in automation technology. They allow users to complete their tasks quickly, easily and cost-effectively. All that is required is a little bit of programming effort. Igus’ lubrication-free linear axes developed in several stages are now available. Depending on the application’s requirements, two-axis linear or flat linear robots and three-axis room linear robots can be selected. At Motek, Igus introduced a new line robot and a new room linear robot with an enlarged workspace, which allows users to move even greater loads across an even larger area.

The two linear robots consist of pre-configured linear modules, aluminium linear axes, NEMA stepper motors and encoders. The new line robot can transport loads of up to 50 N in a workspace of 800 × 500 mm at a maximum speed of up to 1 m/s. “The investment risk of €2,100 for the line robot is manageable, so that our automated pick-and-place applications for assembly tasks pay for themselves in less than six months. This means that decision makers have a low level of risk,” says Alexander Mühlens, head of automation technology at Igus. The new room linear robot is a good option for more complex tasks. It can transport loads of up to 50 N in a workspace of 800 × 800 × 500 mm at a maximum speed of 0.5 m/s. Two ZLW toothed belt axes and one GRR gear rack axis ensures precise guidance and lubrication-free operation.

The new linear robot solutions are used in pick and place, bin picking and sorting tasks. Most of these processes have been moved to the end of the production line. This was also true at FachPack 2019 in the showcase of SSI Schäfer, the intralogistics specialist. The new drylin room linear robot automated the provision of sensitive products using a transport box with a thermoform insert. The specially developed packaging and the use of a linear robot allowed various colored handles to be pre-sorted for the production of a household appliance. There are other linear robot use scenarios in microelectronics and automated testing. (www.igus.com)
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Global Bearing Sources for the Power Transmission Industry

What is the general consensus on the current quality and viability of global bearing sources for the power transmission industry?

EXPERT RESPONSE PROVIDED BY CHRIS NAPOLEON. There is no broad brush answer to this question. The power transmission industry can utilize the global supply chain successfully. The global supply chain can successfully support the application demands of the power transmission industry. These are factual statements; however, they unequivocally must be followed up by the statement that a very thorough technical analysis of the supplier one intends on using is required to ensure success. There are literally thousands of bearing manufacturers in the world—all wanting your business and all claiming they can meet both commercial requirements of price and lead time and technical needs of the application. The commercial needs are fairly easy to evaluate. The technical aspects of overall bearing quality are far more difficult to identify and evaluate by an OEM design engineer. This is because their area of expertise is typically not in bearing design and even less in understanding and establishing bearing manufacturing control limits that construct the basis of bearing quality. Indeed, most critical bearing characteristics are not under the direct control of any national or international standard.

So, if a power transmission OEM intends on utilizing the global bearing supply chain—which is almost a necessity, since even the most notable bearing manufacturers are global in their production—one needs to have, develop or partner with someone who understands bearing qualification practices. When this is executed properly, certain global bearing suppliers can viably provide acceptable quality for the power transmission industry. I’ve traveled and inspected bearing product from around the world and have seen the best and worst that’s out there, and year after year I see OEMs successfully sourcing bearings to meet extremely demanding applications in all industrial applications. Every successful outcome started with the development and execution of a specific technical bearing analysis process. One other important point is that those that are successful fully understand that there is a cost associated with the process necessary to gain sufficient knowledge to ensure one’s success. There is no golden egg. Success in the utilization of the global bearing market requires time and money, and must be part of the equation. Additionally, the road to success might include initial failure of a supplier and the need to make changes and re-inspect and test to meet the necessary requirements. This is common and, although painful, it pales in comparison to the time, cost and pain associated with catastrophic field failure prior to the expiration of the warranty period.

In conclusion, all industries, including power transmission, can look to the global bearing supply chain for solutions. There are plenty of world class suppliers out there; you simply need to develop a plan consistent with the risk associated with the application and plan accordingly with time and both financial and technical resources. (Chris Napoleon is president/chief engineer of Napoleon Engineering Services, www.nesbearings.com; cnapoleon@nesbearings.com.)
**Gearmotor Paint Coatings**

**A Focus on Electrodeposition Coating (E-Coat) in the Gearmotor Industry**

Thomas Colacino, Brother International Corporation

**Introduction**

The following article explains the commonly used paint components and methods within the gearmotor industry, with a focus on electrodeposition coating (E-Coat). These processes will be described in general, with a closer examination of the E-Coat applications steps. Some pros and cons of each method will be presented along with comparative test results showing the benefits of E-Coat.

**Explanation & Components of Paints**

In the gearmotor industry, there are different paint options available from a myriad of manufacturers. Generally, most paints are made from three primary components: resins, solvents, and pigments (Table 1).

**Common Application Methods of Paint in the Gearmotor Industry**

There are multiple ways to apply these paints to the gearmotor. The three application methods discussed in this article are: spraying, powder coating, and electrodeposition coating (E-Coat).

Spray painting is a method that is used across many industries. This application method involves a paint composed of solvents and pigments that is sprayed through a paint gun. This atomizes the paint into small particles and the spray is directed at the workpiece. Once the paint is applied, the workpieces are left out to dry through natural convection (air drying). The thickness of the coating varies during each application, but a common thickness for spray paints would be around 20-30 μm, uniformly distributed across the work surface. It is best used when a company has only a few different pieces to be painted, in large quantities. This method uses water as a solvent and since there are no VOCs, it has minimal negative environmental and human impact.

Powder coating is a method in which powdered paint is charged by a powered gun and applied to a grounded object using static electricity. After painting, the workpiece is baked in a drying oven to form a hard-exterior coating. The thickness of the coating varies during each application, but a common thickness for powder coat paints would be around 50-90 μm. It is best used when a company has a moderate amount of workpieces, in moderate variety. This method does not involve any solvents, due to its use of an electric charge to adhere the paint, so it has minimal negative environmental and human impact.

E-Coat is a method in which a vat of paint is given a positive charge (cationic) and the workpiece is given a negative charge (anionic). The workpiece is then submerged in the paint, and the difference in charge causes the paint to attract to the piece. This ensures complete and even coverage with paint. This is one of the reasons why it is used extensively in the automotive industry. After painting, the workpiece is baked in a drying oven for the paint to form a hard, electrically-insulated exterior. The thickness of the coating is the most consistent out of the three methods mentioned. A common thickness for E-Coat would be around 20-30 μm, uniformly distributed across the work surface. It is best used when a company has only a few different pieces to be painted, in large quantities. This method uses water as a solvent and since there are no VOCs, it has minimal negative environmental and human impact.

See Table 2 for a summary of the differences between the paint application methods mentioned above.

With this outlined, it is safe to say any of the three painting methods can be a viable option depending on the variety and quantity of gearmotors to be

---

Table 1: Description of Paint Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Properties / Use</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resin</td>
<td>Main component in clear coatings</td>
<td>Synthetic resin, fats and oils</td>
</tr>
<tr>
<td></td>
<td>Provides a translucent top-layer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protects the paint and surface underneath</td>
<td></td>
</tr>
<tr>
<td>Solvent</td>
<td>Component in sprayed paints</td>
<td>Esters, ketones, water, etc.</td>
</tr>
<tr>
<td></td>
<td>Excludes powder coating</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Allow the pigments to disperse and adhere to the workpiece</td>
<td></td>
</tr>
<tr>
<td>Pigment</td>
<td>Gives the paint its color</td>
<td>Color pigments, anticorrosive pigments, etc.</td>
</tr>
<tr>
<td></td>
<td>Can give the paint special properties</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i.e. chemical resistance, anti-corrosion, etc.</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Gearmotor Coating Comparison

<table>
<thead>
<tr>
<th>Coating Method</th>
<th>Solvent</th>
<th>Drying Method</th>
<th>Coating Film Thickness (μm)</th>
<th>Use</th>
<th>Environmental Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spray</td>
<td>Yes (VOC)</td>
<td>Convection, Baking</td>
<td>20+</td>
<td>High variety, low quantity</td>
<td>High</td>
</tr>
<tr>
<td>Powder</td>
<td>None</td>
<td>Baking</td>
<td>50-90</td>
<td>Intermediate variety and quantity</td>
<td>Minimal</td>
</tr>
<tr>
<td>E-Coat</td>
<td>Water</td>
<td>Baking</td>
<td>20-30 (Uniform)</td>
<td>Low variety, high quantity</td>
<td>Minimal</td>
</tr>
</tbody>
</table>
painted. Due to inconsistent coating thicknesses, certain coatings are more susceptible to problems such as paint coverage, uniform distribution, peeling, bubbling, cracking, etc. In the long run this may lead to issues with corrosion of the gearmotor case, contamination (in food processing applications), and a poor appearance. E-Coat is a simple process that can minimize the chances of these issues occurring because it ensures a uniform paint distribution across the surfaces it is applied to. These results can be achieved without E-coat by using powder coating, but it requires more effort, skill, and overall care to ensure a high-quality finish.

**E-Coat Application Stages**
There are not many steps in the E-Coat application process, making it simple to perform and replicate. A simplified diagram of the process can be found in Figure 1.

**Potential Benefits and Comparative Testing Results**
Depending on the quality of the application process, the following benefits can be realized:
- Provide protection from impacts
- Resist paint wear from oil exposure
- Stay adhered regardless of humidity
- Won’t chip or peel under extreme temperature changes
- Won’t corrode when in contact with salt water
- Won’t corrode after washdowns with acidic or alkali solutions
- Ensure a uniform coating thickness
- The flatness of the mounting surface is always uniform

Paint performance testing was conducted, and results that support these claims can be found in Table 3.

![Figure 1](image-url)  
*To prepare for painting, the workpiece is first washed in water. Then, the surface is degreased using an alkali-based degreaser and washed again. This applies to both iron and aluminum workpieces. If the workpiece is made from a non-ferrous type of aluminum alloy, a coating agent must be applied to the piece to chemically convert the surface to one that will accept the E-Coat paint. After, the pieces are given a negative electric charge, and immersed in a tank of positively charged paint; the paint is now adhered to the piece. The pieces are then washed again to remove and paint solids that may have adhered to the surface, to ensure a smooth finish. They then move to a drying oven, where the paint will harden. Lastly, the pieces must cool down, and the process will be complete.*

<table>
<thead>
<tr>
<th>Test Items</th>
<th>Brother E-Coat</th>
<th>Result</th>
<th>Brother Powder Coat</th>
<th>Result</th>
<th>Computer 1 (Standard powder coat)</th>
<th>Computer 2 (Standard powder coat)</th>
<th>Computer 3 (Food)</th>
<th>Standard/Test Coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adhesiveness</td>
<td>Pass</td>
<td></td>
<td>Pass</td>
<td></td>
<td>Fail</td>
<td>Fail</td>
<td>Fail</td>
<td>Cut the coating to the work surface using a single blade knife, grid pattern (100 squares, 1 mm × 1 mm) Use tape with adhesion strength of 10±1 N or more per 25 mm to peel the squares</td>
</tr>
<tr>
<td>Oil resistant (grease)</td>
<td>Pass</td>
<td></td>
<td>Pass</td>
<td></td>
<td>Pass</td>
<td>Fail</td>
<td>Pass</td>
<td>ISO 2409-1992 50°C, RH98% or more, 240 hours</td>
</tr>
<tr>
<td>Moisture resistance (humidity)</td>
<td>Pass</td>
<td></td>
<td>Pass</td>
<td></td>
<td>Pass</td>
<td>Fail</td>
<td>Pass</td>
<td>50°C, RH98% or more, 240 hours</td>
</tr>
<tr>
<td>Boiling water resistance</td>
<td>Pass</td>
<td></td>
<td>Pass</td>
<td></td>
<td>Fail</td>
<td>Fail</td>
<td>Pass</td>
<td>95°C or more, 1 hour</td>
</tr>
<tr>
<td>Pencil hardness</td>
<td>Pass</td>
<td>4H</td>
<td>Pass</td>
<td>4H</td>
<td>Pass (2H)</td>
<td>Pass (H)</td>
<td>Fail (F)</td>
<td>ISO/DIS 15184 Determined film hardness using the pencil test</td>
</tr>
<tr>
<td>Salt-resistant spraying</td>
<td>Pass</td>
<td></td>
<td>Pass</td>
<td></td>
<td>Fail</td>
<td>Fail</td>
<td>Pass</td>
<td>5% NaCl, 35°C, 240 hours</td>
</tr>
<tr>
<td>Acidity resistance</td>
<td>Pass</td>
<td></td>
<td>Pass</td>
<td></td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>5% H₂SO₄, 48 hours</td>
</tr>
<tr>
<td>Alkali resistance</td>
<td>Pass</td>
<td></td>
<td>Pass</td>
<td></td>
<td>Fail</td>
<td>Fail</td>
<td>Fail</td>
<td>5% NaOH, 48 hours</td>
</tr>
<tr>
<td>Coating film thickness (μm)</td>
<td>15.8</td>
<td>90.2</td>
<td>77.63</td>
<td>97.2</td>
<td>368.8</td>
<td>Film thickness meter (μm)</td>
<td>Sample size = 1, case material = aluminum</td>
<td></td>
</tr>
</tbody>
</table>

*Table 3 Test Results: Brother Gearmotor E-Coat vs. Comparable Paint Test Results*

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Conclusion

There are three primary methods used for painting gearmotors: spray painting, powder coating, and E-Coat. While all three can be used, the uniform paint coverage that E-coat provides allows it to potentially prevent many problems that may arise with inconsistent coating thicknesses. E-Coat paint has a lower environmental impact, is easy to scale, and provides a hardened, electrically insulated paint coating to protect gearmotors for their usage life.

Brother Gearmotors offers E-Coat as a standard coating on almost all gearmotor products. They are permanently sealed for a high-quality finish that ensures consistently tough, water-tight, chemically-resistant units that withstand harsh conditions.

For more information:
Brother Gearmotors
200 Crossing Blvd.
Bridgewater, NJ 08807-0911
Phone: (866) 523-6283
www.brothergearmotors.com

Figure 2  Brother Gearmotors offers E-Coat as a standard coating on almost all gearmotor products.

Thomas Colacino is an Applications Engineer at Brother International Corporation. Brother Gearmotors offers a full line of gearmotors and accessories to meet virtually any manufacturing power generation need. The company’s portfolio includes interior permanent magnet motors (IPM), brushless DC, AC Induction and other high-quality gearmotors and reducers for industries such as food & beverage, packaging and material handling. All Brother Gearmotors products are backed by a five-year limited warranty.

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The 2019 Power Transmission Engineering Buyers Guide was compiled to provide you with a handy resource containing the contact information for significant suppliers of power transmission components.

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www.top-mei.com

Torque Transmission
www.torquetrans.com

Transplcy
www.transplcy.com

Trojjan Gear Inc.
www.trojjan-gear.com

TSS Rotterdam B.V.
www.tss.nl

Tsubaki of Canada Limited
www.tsubaki.ca

TVT America, Inc.
www.tvtamerica.com

U.S. Tsubaki
301 E. MARQUARD DR.
WHEELING, IL  60090
Phone: (847) 459-9500
Fax: (847) 459-9515
sales@ustsubaki.com
www.ustsubaki.com

Vision International
www.engineech.com

Vision Quality Components, Inc
www.vision글s.com

VL Motion Systems Inc.
www.vlmotion.com

Voith Turbo Inc
voith.com/usa/en/index.html

Volta Belting
voltabeltting.com

W.M. Berg
www.wmberg.com

Wajax
www.wajax.com

WJB Group
www.wjbgroup.com

WWM Transmissions Ltd
www.wmm-trans.co.uk

Yogi Bearings
www.yogibeearings.com

York Industries
www.york-ind.com

Zeon Belts Pvt. Ltd.
www.zeonbelts.com

BRAKES

Affiliated Distributors
www.adhq.com

Andantex USA Inc.
www.andantex.com

Applied Dynamics
www.applied-dynamics.com

Applied Power Solutions
dpscorp.com

Area Distributors Inc.
areadist.com

BDI - Bearing Distributors Inc.
www.bdixpress.com

Bearing Engineering Company
bearingengineering.com

Bearing Headquarters
www.bearingheadquarters.com
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<th>Company Name</th>
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<td>Bearing Engineering Company</td>
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<td>Bibby Turboflex</td>
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<td>Cabat Inc.</td>
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<td>CENTA Power Transmission</td>
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<td>Commercial Gear &amp; Sprocket Co. Inc.</td>
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<td>Coremo Ocmea S.r.l.</td>
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<td>Cross + Morse</td>
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<td>Dalton Bearing Service, Inc.</td>
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<td>Desch Canada Ltd.</td>
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<td>DieQua Corp.</td>
<td>180 COVINGTON DRIVE BLOOMINGTON, IL 60108</td>
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<td>Drive Lines Technologies Ltd</td>
<td><a href="http://www.drive-lines.co.uk">www.drive-lines.co.uk</a></td>
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<td>Dynacte Manufacturing Inc.</td>
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<td>EIDC Industrial Clutches and Fk(Mfg.)</td>
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<td>Emco Dynatog Pvt. Ltd.</td>
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<td>Flux Drive Inc.</td>
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<td>Force Control</td>
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<td>Formsprag Clutch</td>
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<td>Ghatge Patil Industries</td>
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<td>GMN Bearing USA, Ltd.</td>
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<td>Howdon Power Transmission Limited</td>
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<td>Huco Dynatork</td>
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<td>IBT Industrial Solutions</td>
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<td>Industrial Clutch Parts Ltd.</td>
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<td>Industrial Friction Materials Ltd.</td>
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<td>Inertia Dynamics, Inc.</td>
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<td>ISC Companies</td>
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<td>Logan Clutch Corp</td>
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<td>13200 6TH AVENUE NORTH PEYTON, MN 53441</td>
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<td>New Torque, Inc.</td>
<td>newtorque.com</td>
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<td>Nordex, Inc.</td>
<td>426 FEDERAL ROAD BROOKFIELD, CT 06804</td>
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<td>North American Clutch &amp; Driveline</td>
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<td>Pethe Engineering Private Limited</td>
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<td>PTD Outlet: Power Transmission Distributors</td>
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<td>R+W America</td>
<td>254 TUBEWAY DRIVE CAROL STREAM, IL 60188</td>
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<td>Snow Nabschiedt Power Transmissions Inc</td>
<td><a href="http://www.snipt.com">www.snipt.com</a></td>
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<td>SPX Cooling Technologies, Inc.</td>
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<td>SSS Clutch Company</td>
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<td>Supreme Gear Co.</td>
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<td>T.E.A. Machine Components</td>
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<td>Taiwan Precision Gear Corp.</td>
<td><a href="http://www.tpg-tw.com">www.tpg-tw.com</a></td>
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<td>TB Woods</td>
<td><a href="http://www.tbwoods.com">www.tbwoods.com</a></td>
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<td>Team Industries</td>
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<td>Thomson Industries Inc.</td>
<td><a href="http://www.thomsonlinear.com">www.thomsonlinear.com</a></td>
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<td>Tolomatic, Inc.</td>
<td><a href="http://www.tolomatic.com">www.tolomatic.com</a></td>
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<td>Transply Inc.</td>
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<td>TVT America, Inc.</td>
<td><a href="http://www.tvtamerica.com">www.tvtamerica.com</a></td>
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<td>Twiflex Limited</td>
<td><a href="http://www.twiflex.com">www.twiflex.com</a></td>
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<td>VL Motion Systems Inc.</td>
<td><a href="http://www.vlmotion.com">www.vlmotion.com</a></td>
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<td>Vortex Engineering Works</td>
<td><a href="http://www.vortexclutch.com">www.vortexclutch.com</a></td>
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<td>W.M. Berg</td>
<td><a href="http://www.wmberg.com">www.wmberg.com</a></td>
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<td>Wajax</td>
<td><a href="http://www.wajax.com">www.wajax.com</a></td>
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### 2019 Buyers Guide

#### CONTROLS

**ABB Motors and Mechanical Inc.**
5711 R.S. Boreham, Jr. Street
Phone: (479) 646-4711
Fax: (479) 648-5792
www.baldor.com

**Ace World Companies**
www.aceworldcompanies.com

**ACS Motion Control**
www.acsmotioncontrol.com

**Advanced Control Systems Corporation**
www.acscontrol.com

**Aerotech Inc.**
www.aerotech.com

**Affiliated Distributors**
www.affdistributor.com

**Allied International**
www.alliedinternational.com

**Allied Motion**
www.alliedmotion.com

**American Rotary Phase Converters**
www.americanrotary.com

**Anaheim Automation, Inc.**
www.anaheimautomation.com

**Applied Dynamics**
www.applied-dynamics.com

**Applied Power Solutions**
apscorp.com

**Area Distributors Inc.**
areadist.com

**ATO Inc**
www.atoa.com/

**Automation Direct**
www.automationdirect.com

**Axu s.r.l.**
www.axu.it

**BDI - Bearing Distributors Inc.**
www.bdiexpress.com

**Bearing Engineering Company**
bearingengineering.com

**Bearing Headquarters**
www.bearingheadquarters.com

**Bearing Service Company**
www.bearingservicecompany.com

**Binsfeld Engineering Inc.**
www.binsfeld.com

**BK Power Systems - An Integrated Corrosion Co.**
www.bkpowersystems.com

**Bodine Electric Company**
www.bodine-electric.com

**Bonfiglioli Riduttori S.p.A.**
www.bonfiglioli.com

**Bonfiglioli USA**
www.BonfiglioliUSA.com

**Boston Gear**
www.bostongear.com

**CNC Center**
www.cnccenter.com

**Control Switches International Inc**
www.controlswitches.com

**Cutes Corporation**
www.cutes.com.tw

**Dalton Bearing Service, Inc.**
www.daltonbearing.com

**Dellner Brakes AB**
www.dellner-brakes.com

**DieQua Corp.**
180 COVINGTON DRIVE
BLOOMINGTON, IL 60208
Phone: (630) 980-1133
Fax: (630) 980-1232
info@diequa.com
www.diequa.com

**Dover Motion**
www.dovermotion.com

**Drive Lines Technologies Ltd**
www.drivelines.co.uk

**Dunkermotoren USA Inc.**
www.dunkermotoren.com

**Dynamic Structures and Materials, LLC**
www.dynamic-structures.com

**Eagle PLC**
www.eagleplc.com

**Electronic Machine Parts**
www.empregister.com

**Emerson Industrial Automation - Drives & Motor**

**EquipNet**
www.equipnet.com

**Festo Corporation**
www.festo.com/usa

**Flux Drive Inc.**
www.fluxdrive.com

**Force Control**
www.forcecontrol.com

**FSI Technologies Inc.**
www.fsinet.com

**GoHz Power Supply Inc.**
www.goHz.com

**Hallmark Industries Inc.**
www.hallmarkind.com

**Hansen Corporation**
www.hansen-motor.com

**Heidenhain Corporation**
www.heidenhain.com

**Hoffmann Technics AG**
www.hoffmann-tech.ch

**HPB Motion Control Co. Ltd.**
www.hpb-industry.com

**I-MAK Reduktor**
www.imakreduktor.com

**IBT Industrial Solutions**
www.ibtic.com

**Industrial Clutch Parts Ltd.**
www.icp.co.uk

**Inertia Dynamics, Inc.**
www.ididch.com

**Intellidrives, Inc.**
www.intellidrives.com

**ISC Companies**
www.isccompanies.com

**Johnson Industries Ltd.**
www.brakes.ca

**JVL Industri Elektronik A/S**
www.jvl.dk

**K+S Services**
www.k-and-s.com

**KB Controls**
www.kb-controls.com

**KEB America, Inc.**
www.ketblog.com

**Kinematics Manufacturing, Inc.**
www.kinematicsmfg.com

**Kollmorgen**
www.kollmorgen.com

**Leeson Electric**
www.leeson.com

**Lenze Americas**
www.lenze.com

**Logan Clutch Corp**
www.loganclutch.com

**Magtrol, Inc.**
www.magtrol.com

**Malloy Electric**
www.malloywind.com

**Marshall Wolf Automation Inc.**
www.wolfautomation.com

**Mavior Motors, S.a.**
www.mavior.es

**Maxcess**
www.maxcessint.com

**Maxon Precision Motors**
www.maxomotorusa.com

**MCIO, Incorporated**
www.mcio.com

**Micronor Inc.**
www.micronor.com

**Midwest Motion Products**
www.midwestmotion.com

**Mitsubishi Electric Automation, Inc.**
us.mitsubishielectric.com/fa/en

**Modicon PLC**
www.modiconplc.com

**Molon Motor and Coil**
300 NORTH RIDGE AVE.
ARLINGTON HEIGHTS, IL 60005
Phone: (847) 253-6000
Fax: (847) 259-0299
www.molon.com

**MOONS’ Industries**
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**Motion Industries**
www.motionindustries.com

**MPT Drives, Inc.**
www.mptdrives.com

**MRO Electric and Supply**
www.mroelectric.com/

**MROS Supply**
www.mrosupply.com

**New Power Electric (USA) LLC**
www.usa-newpower.com

**New Torque, Inc.**
www.newtorque.com

**Northwest Electric Motor Company**
northwestmotor.com

**Novotec Argentina SRL**
www.novotecargentina.com

**Owvio LLC**
www.owvio1c.com

**Ormecc**
www.ormecc.com

**Parker Hannifin SSD Drives Div.**
www.parker.com/ssdusa

**Phytron, Inc.**
www.phytron.com

**PI (Physik Instrumente) L.P. Piezo Actuator Nano**
www.pi-usa.us

**Potomac Electric**
www.potomacelectric.com/

**Power Electric**
www.powerelectric.com

**Power inverter Inc.**
www.powervinverter.org/

**Power Jack Motion**
www.powerjackmotion.com

**Precipart**
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**PTD Outlet: Power Transmission Distributors**
www.ptdoutlet.com

**Rae DC Products Group**
www.raedcmotors.com

**Regent Controls, Inc**
www.regentcontrols.com

**Rockwell Automation**
www.rockwellautomation.com

**Rocky Mountain Technologies**
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COUPLINGS & U-JOINTS

Accent Bearings Co. Inc.  
www.accentbearing.com

Accurate Gear and Machine, Inc.  
www.accurategear.com

Acorn Industrial Services Ltd.  
www.acorn-ind.co.uk

Affiliated Distributors  
www.affd.com

AGI Automation Components  
wwwagi-automation.com

Agro Engineers  
www.direngineers.com

AISCO Industrial Couplings  
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Ameridrives  
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Ametric / American Metric Corporation  
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www.applied-dynamics.com

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www.apsp.com

Area Distributors Inc.  
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Artec Machine Systems  
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Ascent Precision Gear Corporation  
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Axu s.r.l.  
www.axu.it

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www.brmach.com

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www.bmgears.com

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In Part I we explored various motor technologies used today for industrial and traction motor design. Here in Part II we will explore another motor option: reluctance motors.

Although invented in the 1800s, the variable switched reluctance (VSR or SR) motor was re-discovered in the 1990s when the electronic power switches, FETs, IGBTs, became readily available on a commercial basis. In recent years the VSR has once again attracted a lot of attention as a cost-effective alternative to the permanent magnet (PM) motor.

In Figure 1 we show the basic diagram of the VSR lamination. Other key parts of the VSR motor are shown in Figure 2. Finally, a picture of a production VSR motor is shown (Fig. 3).

The VSR has a number of rotor and stator teeth where the number of rotor teeth \( n_r \) is typically ±2 of the number of stator teeth \( n_s \), and \( n_s \) is an integer multiple of 2 times the number of phases \( n_p \). The VSR is characterized by its ratio of rotor-to-stator teeth and common ratios are 6:4 and 12:8 for a 3-phase motor and 8:6 for a 4-phase motor.

Unlike most other brushless motors, the coils are wound concentrically around a single stator tooth (Fig. 2) which reduces the end-turn length, copper weight and copper losses. It also reduces the cost to manufacture the VSR motor due to its simple winding patterns.

The VSR motor can be very efficient; for example, a 5 KW VSR motor can reach up to 95% efficiency. And a larger VSR motor can have even higher efficiency. The VSR delivers constant torque — from starting torque up to a “base” speed — and the constant power above up to 3× the base speed without a significant loss in efficiency. The speed/torque curve of a typical VSR motor is shown (Fig. 4).

An added advantage of the VSR is that it can be largely controlled by properly turning the phases “ON” and “OFF” at the correct times when running at a constant speed, and no additional current control will be required; this increases the drive efficiency and can reduce the controller cost.
The main drawback of the VSR motor is that each of its phases must be controlled independently—which requires two motor leads to be brought out from the motor to the controller for each phase—and the controller requires additional components, compared to a permanent magnet (PM) brushless motor (BL). In Figure 5 we show the flux pattern of a typical VSR lamination.

The VSR motor design requires high flux concentrations in the lamination steel for efficient operation and VSR motors typically operate at 1.8T–2.2T flux density, which is higher than those of similar PM BL motors. Due to the high flux densities in the steel, it is very important to minimize the back-iron and tooth width, which can result in a mechanically “weaker” lamination compared to that of a similar-sized PM or induction motor.

Also, the airgap of the VSR is small, i.e. 10–20 mils—which presents mechanical challenges—and it results in strong, radial magnetic forces acting on the rotor. These forces, coupled with the thin outer lamination ring, result in acoustical noise that is generated in the VSR motor; so they can be noisy unless additional design measures are taken.

An additional concern typically associated with VSR motors is the torque ripple, as shown in Figure 6.

The VSR motor is commonly considered “noisy,” but many successful designs exist where the motor runs very quietly, i.e. — the Neptune washer VSR motor made by Emerson. We have also compared noise levels of a PM traction motor versus a properly designed VSR motor and found the noise measurements in the passenger compartment to be within ±3dB from each other, with neither motor being clearly quieter.

However, there is a second type of reluctance motor which, until recently, did not gain much attention,—the synchronous reluctance motor (SYR)—and it has only recently generated serious interest.
Figure 7 shows the lamination design of a synchronous reluctance motor and Figure 8 shows the flux distribution in the SYR lamination; and in Figure 9 is a photo of a SYR motor.

In Figure 10 we show the speed/torque curve of a SYR motor.

The SYR delivers constant torque from stall (0 RPM) up to a “base” speed, and the constant power above the base speed. The SYR can be operated in this constant power region up to 3x the base speed without a significant loss in efficiency. Furthermore, the SYR can achieve very high operating efficiencies at high speed and we are designing a 3” diameter SYR motor with a 1.5” stack that can operate at 10 KW at 36,000 rpm, while maintaining above 93% motor operating efficiency.

The SYR has a distributed winding, just like the PM BL motor and the AC induction (ACI) motors, e.g.— the ABB SYR in Europe uses an existing AC stator and simply added a reluctance rotor. This ABB motor has become a very successful SYR motor product line, but most SYRs today are custom-designed specifically as SYR motors — especially in the U.S — which yield smaller and more efficient SYR motors.

The SYR can be manufactured with the same winding equipment and facilities as existing brushless and induction motors. No magnets need to be glued and/or retained, which further simplifies SYR manufacturing and results in cost savings.

Like the PM brushless and the ACI, the SYR requires one motor lead per phase and, with minor software changes, it can run with the same controller hardware as the PM brushless motor.

Because the stator backiron is generally thicker than that of the VSR motor, the SYR runs quieter. Testing on some motor comparisons has shown that the SYR has a noise signature that is comparable to that of a PM BL motor in specific applications.

The operating efficiencies of the SYR motor are slightly
less than those of a high-performance neodymium PM BL, but that is offset by a lower manufacturing cost compared to the brushless motor and a significantly lower controller cost compared to the VSR.

The SYR also has an almost constant torque. A typical torque ripple curve is shown in Figure 11; it shows only a small variation of the motor’s torque as a function of its position.

Also, while the SYR will have its highest operating efficiencies when excited with sinusoidal waveforms (AC), the SYR will also perform very efficiently when energized with trapezoidal waveforms — just like the brushless DC motor. This allows for low-cost Hall sensors to be used for feedback. Both the VSR and SYR can be operated sensor-less, using proprietary sensorless controls for positioning and speed control of SYR motors without loss in performance for high-temperature automotive and military applications.

Also, since the SYR motor has no magnets, there is no risk of demagnetization during overload conditions and the motor can easily operate in higher ambient temperature environments — a key feature for some advanced automotive, down-hole drilling and military applications.

In Table 1 we show a comparison of material weights: one component in the cost comparison used when deciding which motor to use.

This comparison clearly favors the SYR in this specific example and, if the controller cost were taken into account, the SYR and the PM brushless will be the prime candidates.

Potential customers have been quite receptive, and working designs are under development to replace offshore PM BL motors with SYRs that can be cost-effectively produced domestically.

Next time you need a low-cost, high-performance motor, you should look beyond the PM BL motors and consider the reluctance motors — specifically the SYR — as an alternative to a lower-cost motor drive system.

For more information.
Questions or comments regarding this paper? Contact the author at Rocky Mountain Technologies at 406-225-7120 or info@RockyMountainTechnologies.com.

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Reliability Safeguarding for an 8 MW Wind Energy Gearbox in Serial Production: Prototype and Process Development Ensuring Stable Quality at the Highest Level


Market Challenges and Motivation
The offshore market segment is forecasted to grow with a 16% cumulative annual growth in 2015 to 2020. The recent tender process leads to low power prices for offshore wind, e.g. — Dutch Borssele III and IV with 54.5 EUR/MWh. Therefore, offshore has the potential of reducing the levelized cost of energy, particularly when leveraging economies of scale and industrial maturity.

At the same time, a gearbox exchange on an offshore turbine causes repair costs of at least a million Eur; thus, the highest product reliability is required to safeguard business certainty.

Project and Design Characteristics
In 2010, ZF (formerly Bosch Rexroth) started the development of the 8 MW gearbox. In 2013 ZF delivered the first prototype. The gearbox design was validated within a huge validation program on the customer’s system test rig, as well as on the prototype turbine.

After passing more than 10 gate reviews and design reviews according to the customer’s development process, and having implemented some design improvements, the 0-series production began in 2015. The qualification of the manufacturing process was ensured by applying four audits per year, together with the turbine manufacturer and end-customers. Also a certification body proved and released the processes.

The manufacturing processes’ quality has continuously improved. Meanwhile, the 100th gearbox has been supplied successfully in May 2017.

ZF uses the differential gearbox for this application — a proven design applied in more than 2,500 gearboxes in the power range from 2.5 to 3 MW since 2003.

The 8 MW design consists of three planetary stages with a total ratio of about 38 (Fig.1). The gearbox weight is about 71.5 metric tons, with a diameter and length of about 3,000 mm.
The gearbox is originally rated for 8,400 kNm, with an upgrade margin up to significantly more than 9,000 kNm without design changes.

The concept is characterized by a power split on two planetary stages on the high torque input side. A further planetary stage combines the power flow again (Fig. 2). The concept allows using comparably small gear wheels and small bearings. At the same time, high total ratios up to i = 50 can be achieved, since the stationary gear ratio is only in the range of 3.2-3.5 in each stage. The small stationary gear ratio provides the space for implementing further alignment functionality like, e.g., the double-cardanic sun system. The gear’s aspect ratio is approximately 50% smaller than in conventional planetary gearbox architectures. The torque split allows using comparable small modules, which in turn lead to small gear diameters and small teeth. The component sizes and weight lead to advantages for logistics, material handling and heat treatment processes.

The differential gearbox concept provides possibilities for a 50% power density increase in the same volume by using numerous planets.

Prototype Development

Reliability engineering. A strong focus was put on reliability during the entire prototype development (Fig 3). Starting with comprehensive field experience with the differential gearbox concept, engineering experience of about 25 years in wind business and knowledge in applying sophisticated simulation tools, three elements of reliability engineering became important:

- The reliability prognosis focuses on the prediction of the component’s reliability and the overall gearbox system. By an additional sub-project, applicable calculation methods have been developed (see also ZF’s report on International Conference on Gears 2015 (Ref. 3)). The fundamentals of that approach are based on Bertsche (Ref. 1).
- Proper risk management by using structured methods like the failure mode effect analyses (FMEA) for designs — but also for processes. The FMEA has been carried out and updated throughout the entire development process. The method delivers input for the simulation tasks, as well as for the validation program.
- The validation program is adjusted to the verification topics. The results are processed in the FMEA and the risks are mitigated accordingly. The main pillars of the validation program are component, rig and field testing.
- Many of the described actions exceed the requirements of the IEC 61400-4 standard (Ref. 2).

Simulations. The theoretical reliability has to be safeguarded by comprehensive simulations considering all drivetrain loads. The simulation is necessary to predict early failure risks and thus reduce the validation time and costs as good as possible.

Therefore, a complete model of the drivetrain has been set up in a finite element model, as well as in a multi-body model, to adequately examine the static and dynamic influence from the overall system on the individual components (Fig. 4).

Due to the huge size of the model it was important to find...
the right modelling strategy, safeguarding the needed accuracy on one hand but keeping the computing time under control on the other hand. This means e.g. applying small mesh elements only locally or using so called “super elements” providing required physical characteristics. Particularly a suitable modelling of contact areas plays an important role to simulate accurate deformations. Using sub-models turned out to be suitable for the model exchange with the customer and the component suppliers.

For the loads and dimensions of an 8 MW turbine, the drivetrain deflections are in the order of magnitude of 1-3 mm. These influences have to be taken into account in a variety of ways in the design — especially on the component level; for example, for the bearing load distribution and the tooth modifications, which are in the order of magnitude of 10 to 30 µm.

As an example, Figure 5 shows the load distribution of a pre-loaded taper roller bearing set supporting the planet carrier; each circle represents the force on an individual roller element. Two bearing rows are shown (red: generator side bearing, blue: rotor side bearing). The state-of-the-art rigid calculation shows a proper load distribution over the rolling elements, whereas the advanced calculation reveals an unequal distribution caused by the varying stiffness of the bearing seat. Applying such an advanced method for all bearings provides an accurate assessment of the structure’s influence on bearing contact pressure at static and dynamic conditions.

The structure deflection has also been taken into account to optimize tooth modifications. For example, the fixation of the ring gear by 52 pieces of M52 stud bolts leads to an axial curvature. This deflection is superposed to the usually applied crowning to determine a most accurate face load distribution in the planet/ring gear contact (Fig. 6).

The dynamic behavior of the entire drivetrain was investigated by means of multi-body simulations (MBS); thus, the interaction of drivetrain structure and gearbox was optimized. On one hand, the Eigen frequencies of the components were adjusted in order to avoid harming resonance conditions; on the other hand, the gear mesh excitation was reduced by investigating the total pitch error of each planetary stage as well as the stiffness variation in the gear meshes (Fig. 7).

Applying a proper teeth number so that a synchronous or asynchronous mesh of sun/planet and planet/ring gear occurs, has been well proven; the right choice depends on the interaction with the gearbox structure. Also, the stiffness variation over the path of contact for both — sun/plant and planet/ring gear mesh — plays an important role for the total pitch error. Finally, a proper microgeometry is useful to influence the mesh frequency. In this case it turned out to be important to focus on the right excitation mode, i.e. — the basic mesh frequency or one of their harmonics.

The structure-borne noise could thus be reduced by approximately 95% — comparing the origin to the optimized design. This means excitation amplitudes in the range of 10 mm/s were simulated with a non-optimized design respective in the order of magnitude of 1.5 mm/s for the optimized design.

Figure 5  Bearing load distribution with state-of-the-art and advanced simulations.

Figure 6  Gear modifications by considering structure deflections.
Validation. According to the risks detected during FMEA and simulation a validation procedure was set up. Different tests were conducted like component tests, robustness and endurance tests as well as a field test (Fig. 8).

With various component tests, several sub-assemblies and process steps were validated; special attention was paid to the roller bearings. Several ZF-owned bearing test rigs were used for that purpose. Also the heat treatment process for the present gears, comprising a module of 29.5 mm, was investigated safely. Destructive component tests supported by heat treatment simulations were conducted. The target was to find a proper combination of surface and core hardness for case hardening depths of around 3-6 mm. Choosing the right quenching technology is a success factor.

The overall system behavior was investigated on the system test rigs, applying dynamic overloads up to 190% of the rated
torque with a duration of more than 1,500 hours. The focus here was on the load distribution in contact elements and on the deformation of the structure. After the system tests the gearboxes were disassembled. All contact surfaces — meaning rolling contact elements as well as flange connections — have been inspected and compared to the simulation.

The inspection revealed that the contact pattern of functional surfaces, as well as the observed micro-movement in flange surfaces, appeared as simulated.

In the upper part (of Fig. 9 as an example), a connection element of the first and second planetary stage is shown. The inspection (left-hand side) demonstrates that the contact location to the mating part is of the same size and at the same location as previously simulated (right-hand side). A reverse calculation of the occurred deformation and pressure was possible.

The lower left part shows the flange connection of the ring gear to the housing. The dark grey zones reveal micro-movement in the flange connection. The lower right picture shows the corresponding simulation. One can see that the micro-movement area (red color) correspond to the inspected

Figure 9  Comparison of system deformation and micro-movement to predicted values.

Figure 10  Contact pattern of gears and bearings and comparison to measurement values.
micro-movement. By means of an accurate simulation the flange and pin/screw design can be optimized such that the amount of micromovement is kept in a controlled and acceptable value. The acceptable values could be derived from field experience.

As usual for wind gearboxes, all meshes have been instrumented by strain gauges to measure the face load distribution, as well as the load sharing between the planets. Also the contact pattern development over several load stages has been visually inspected.

A measured face load distribution of $K_{H1} \approx 1.15...1.17$ and a load sharing of $K_y < 1.05$ has confirmed the gear mesh simulations (Fig. 10). Also, the pre-loaded taper roller bearings revealed an expected contact pattern.

Also the structure-borne noise measurement confirmed the simulated values, i.e. — a deviation of below 5% occurred between simulation and measurement (Fig. 11). The excitation levels are in the range of approximately 1.6mm/s (e.g. first order of gear mesh frequency), and the Eigen frequencies modes are as predicted. The finally applied airborne noise measurement demonstrated that no tonal audibility occurred and that the turbine fulfills onshore noise requirements.

### Optimization of Serial Production

Already during the prototype development phase, manufacturing design was a significant factor. Further process optimization had been reached in a subsequent project, which started with entering the zero-series phase.

Complex correlations between machine and process influences on one hand, and measurement results, on the other hand, have been identified by production-oriented tolerance evaluation with statistical methods (Fig. 12).
Amongst others, the temperature behavior of big-size structure components (e.g. the temperature development from surfaces to core at different wall thicknesses and shapes), has been investigated and implemented in the measurement strategy.

For a better understanding of the component’s deformation in clamping devices, their behavior has been investigated by using FEM analysis; the findings could be used for an enhanced manufacturing strategy with optimized fixations. Additionally, a regular monitoring of the machine conditions has been introduced. Besides the geometrical measurement, frequency analysis of selected units leads to a permanent view on the process conditions and allows measures at an early stage.

A calculation tool has been developed and implemented with the start of series production. Based on the analysis and display of the grinding stock data of gears before grinding, this tool permits quality and cost improvements (Fig. 13).

This tool enables a systematic regulation of the grinding allowance for each type of work piece, and a systematic reduction of the allowance variation spread by identifying and eliminating its root causes.

By using all these strategies on fields of environment, machine, process management and measurement, it is possible to obtain process capability and to face the triangle of tension: time, cost and reliability.

Not only for manufacturing but also for assembly of the 8MW gearbox, special adaptations to the processes had to be done (Fig. 14).

One major aspect concerns the health and safety of the operators. Exemplary for several special tools, the picture on the left side (Fig. 14) shows the adjustable gantry in the main assembly. With respect to the dimensions of components and sub-assemblies, one critical process is the mounting of gears.

To minimize the risk of damage, as well as assembly time and efforts for mounting devices, it is necessary to optimize the shape of the facing edge. The shape has to fulfill the requirements of the two different mounting phases, i.e. — “finding” and “sliding.” The angle of the front edge needs to be big enough for parts finding and the angle for transition into the flank needs to be small enough to ensure a smooth sliding.

For a permanent, stable operation of the gearbox, the quality and the process capability of screw connections are of vital importance. All internal screws and all torque-transmitting...
screws are tightened with electronic torque control.

The interface dimensions of the assembled product are measured by means of advanced measurement methods — here, with a photo-based system. For this reason the gearbox is equipped with reference points and then photographed. With a special software tool, the interfaces dimensions are evaluated with accuracy in the range of about 0.05 to 0.15 mm, depending on the kind of tolerance. This method allows a quick measurement without any need for accessing a measurement machine.

**Summary and Outlook**

The offshore application requires the highest reliability to safeguard business certainty. At the same time, increasing component sizes challenge the entire supply chain. Thus, ZF focused consequentially on reliability engineering for the 8 MW differential gearbox, as well as on reliable serial processes.

In future the focus will be on operational and field data exchange in order to close the information loop and verify further the reliability models. The proven differential gearbox concept yields a power increase up to at least 12 MW by use of same gearbox size and utilization of the existing supply chain and facilities (Fig. 15).

**For more information.**

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**References**


**Dr. Dirk Strasser** in 2000 graduated from FH Iserlohn and Ruhr University Bochum with a degree in mechanical engineering, focusing on construction. His professional work includes (2000-2005) research associate, Institute of Machine Elements, Transmissions and Motor Vehicles, with Prof. Predki, Ruhr University Bochum; (2005-2010) in various positions in the field of industrial and wind gear design for medium-sized transmission companies in the Ruhr area; and (2010-2015) as head of wind gearbox development, Bosch-Rexroth, Witten. Strasser currently (since 2015) has global responsibility for the development of wind gearboxes for ZF Wind Power Antwerp (after sale of Bosch Windbusiness to ZF in 2015).


**Dipl.-Ing. Ralf Sperlich** began his schooling in 1988 - 1991 with an apprenticeship as tool mechanic at VDO Adolf Schindling AG, Frankfurt/M, Germany. From 1994-1997 he pursued mechanical engineering studies at the University of Applied Sciences FH, Frankfurt/M, Germany. From 2005 thru 2007 he took up French Language Studies at the Centre d’Enseignement du Français, Albertville, France and theological studies at Emmaüs, St-Légier, Switzerland. He was later (1997-1998) a design engineer for the mechanical components of robots and hydraulic presses (up to 200kN) at Reis Robotics, Obernburg, Bavaria; (1999-2005) calculation engineer for cranes and components, focus area calculation of machine elements for helical, hypoid and bevel gearboxes for industrial use DEMAG Cranes & Components GmbH, Wetter/Ruhr, Germany; (2006-2012) social welfare development work, in cooperation with international partner organizations and the Evangelical Church in Chad and director of an orphanage there for SAHEL LIFE, Kirchheim/Teck, Germany. Since 2012 Sperlich is design engineer for multi-megawatt offshore wind turbine gearboxes, design lead engineer, for ZF Industrieanttriebe Witten GmbH, Witten, Germany.

**Jörg Münch** in 1983 received vocational training as a mechanic. In 1988 received his degree in mechanical engineering from the University of GHS Wuppertal. Upon graduation, his professional work includes: (1998) gear factory at Köllmann GmbH, in the design and development of extruder and special gearboxes; (2001) at Jahnel-Kestermann GmbH & Co. KG designing and developing special gearboxes (rolling mill, drives chemical plants dredger pumps, water turbine drive); and, since 2007, at Bosch Rexroth AG Witten, in the design and development of transmissions for wind power transmissions. Most recently, Münch is in charge of the 8 MW GPC 840 D gearbox.

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**Figure 15**  Power increase with differential gearbox concept.
Amsted Seals and Forming
ACQUIRES CLARK SEALS NINGBO

Amsted Seals and Forming has acquired Clark Seals Ningbo, to be renamed Amsted Seals Ningbo (ASN). The IATF-certified seal production facility, built in 2012, incorporates the latest in manufacturing, testing, and quality control systems to supply oil, grease, and bearing seals to customers in Asia and the wider global market.

"With 128,000 square feet and future capacity of 96 presses, the acquisition of ASN is part of the ongoing commitment of Amsted Seals and Forming to produce and deliver the highest quality seals in the world," said Michael Carter, president of Amsted Seals and Forming.

Amsted Seals and Forming is committed to long-term investment in the people, quality, technological innovation, and talent development in Ningbo. As manufacturers, engineers, service providers, and innovators, Amsted’s goal is to provide sustainable growth for the people and communities where we operate.

ASN will produce shaft seals, bearing seals and other sealing products for a broad range of applications including rail, heavy duty truck, appliance, automotive, agriculture/ construction, industrial, and outdoor power/recreation.

"We’re excited to welcome the Ningbo facility into our worldwide network of manufacturing excellence," stated Michael Carter, “and be better positioned to respond to our customers’ needs in the most cost-efficient manner.”

As part of the transaction, Amsted Seals and Forming and previous owner Clark Seals LLC out of Tulsa, Oklahoma, entered into a 10-year commercial agreement, establishing Clark Seals as the preferred distributor for certain sealing products.

Amsted Seals and Forming is a part of Amsted Industries, a diversified, global manufacturer of industrial components with a long heritage of cutting-edge manufacturing and continuous product innovation. The Amsted companies are leaders in providing solutions for rail, trucking, automotive, construction and industrial applications. (www.amstedseals.com)

MPIF
ELECTS NEW OFFICERS

Dean Howard, PMT, president, North American Höganäs Co., a subsidiary of Höganäs AB, Hollsopple, Pennsylvania, has been elected the 30th president of the Metal Powder Industries Federation (MPIF), succeeding John F. Sweet, PMT, FMS Corporation, Minneapolis, Minnesota. His two-year term began at the conclusion of the Federation’s annual Powder Metallurgy (PM) Management Summit and 75th Annual MPIF Business Meeting, October 26–28, 2019, in Miami, Florida.

One of the Federation’s six associations also instated a new president following the Summit. Jill Spaulding, Kymera International, Research Triangle Park, North Carolina, has been elected president of the Metal Powder Producers Association (MPPA) and will serve a two-year term. Howard has worked for North American Höganäs Co. for nearly 20 years. He most recently served as president of the MPPA and has served the association and actively for many years.

Howard received MPIF’s Distinguished Service to Powder Metallurgy Award during PowderMet2017 in Las Vegas. He has been a member of APMI International for 26 years. He was chairman of APMI’s Southeast Chapter, served as president of APMI International (2010–2014), and received certification as a Level I Powder Metallurgy Technologist in 1998. (www.mpif.org)

Forest City Gear
HIRES NEW DIRECTOR OF SALES

Forest City Gear has hired Brad Lindmark as director of sales to help meet the growing demands of its wide and diverse customer base throughout the world’s gear-making industries.

Lindmark brings a wealth of sales and marketing experience and a deep familiarity with all facets of inside and outside sales and customer service, along with a strong background in the metalworking industries. This background, combined with his sales and marketing leadership skills, made him an ideal candidate for the position, says Forest City Gear President and CEO Wendy Young.

“Manufacturing the world’s best gears has always been the company’s focus — Brad will help take our sales efforts to that same level,” says Young. “Our sales representatives, and the customers they serve, will benefit greatly from Brad’s hands-on approach, as he works to strengthen existing customer relationships and build new ones.” (www.forestcitygear.com)
Heidenhain
ANNOUNCES LIFE SCIENCES PARTNERSHIP

The new Heidenhain Life Sciences brand partnership is now in place offering ground-breaking technology that enables lab automation for the advancement of medical technology. This development consists of the business partnerships from the Heidenhain Group that include Heidenhain, IMT and Etel brands.

It is well known that delivering high throughput and extraordinary precise platforms are necessary requirements in the effort to speed up life science equipment solutions and at the same time do so cost effectively. This new dedicated Heidenhain partnership helps leverage the synergies of specialized brands to offer such customer-oriented solutions.

The component product lines for laboratory automation within this new partnership include linear scales from Heidenhain, linear motors and controls from Etel, as well as detection systems enabling exceptional positioning and read-out accuracy while maintaining high throughput in sample analysis.

IMT AG Microfluidics offers customized micro- and nano-patterns structures in glass, integration of electrodes, wave-guides and structured functionalization for life science applications. IMT provides flexible process offerings from design consultancy, prototyping to scalable manufacturing. (www.heidenhain.us/applications/lifesciences/)

Hy-Tech Engineered Solutions
ACQUIRES BOTH BLAZ-MAN AND GEAR PRODUCTS & MANUFACTURING

Hy-Tech Engineered Solutions is pleased to announce the acquisition of Blaz-Man Gear and Gear Products & Manufacturing; both Chicago based companies specializing in the manufacture and distribution of custom gears and power transmission gear products. The addition will triple Hy-Tech’s capacity in gear production, as well as bring new
expertise to expand into more complex spiral and straight bevel gear design and manufacture.

“Aside from the advantages this brings to new and existing customers in terms of expanded gear product availability, additional gear design engineering know-how and improved responsiveness, we expect it to help lower costs across the board as the new economies of scale come into play” observes Doug Ciabotti, Hy-Tech’s president. “Adding Blaz-Man and Gear Products means we can better address the needs of dozens of industries for highly engineered gearing, design consulting and reverse engineering”.

“We’re most excited about our expanded capability to handle complex spiral, straight and hypoid bevel gearing applications which have traditionally been difficult to design and manufacture. Combining this bevel gear expertise with our dedicated production capacity for rush and breakdown requirements, as well as for “one-off” special orders, allows us to be a full-service partner to our customers, offering them complete gear solutions”.

The new companies will operate together with Hy-Tech’s current gear company, Quality Gear, forming a new “Power Transmission Division” in Punxsutawney, PA. (www.hy-techinc.com)

FANUC America
OPENS NEW ROBOTICS AND AUTOMATION FACILITY

FANUC America recently held a grand opening celebration at its new 461,000 square-foot North Campus robotics and automation facility in Auburn Hills, MI. Guests included customers, local officials, educators, suppliers, and the media to an official program, ribbon cutting ceremony and facility tour. Special guests include Michigan’s Governor Gretchen Whitmer, Auburn Hills Mayor Kevin McDaniel, and Rochester Hills Mayor Bryan Barnett.

Constructed and in full operation just one year after breaking ground, the new facility houses several departments including engineering, product development, manufacturing and warehousing. Now, to keep pace with the growing demand for robots and automation, FANUC occupies over one million square feet of building space in Oakland County, Michigan.

FANUC displayed an automation tour path that included over 20 robot demonstrations, from its smallest M-1iA delta robot, to the mighty M-2000iA, the world’s strongest robot able to lift 2.3 tons. There was also a variety of hands-on cobot demonstrations highlighting easy setup and programming.

Additional demonstrations included real-world robotic solutions for assembly, material handling, packaging, palletizing, painting and welding. Most of the solutions included FANUC intelligence like integrated iRVision that gives the robots a sense of sight.

A key tour stop during the grand opening featured two FANUC CR-15iA collaborative robots packing bags of weekend nutrition for a local Michigan chapter of Blessings in a Backpack, a non-profit organization that provides children living in food-insecure households with bags of food for the weekend.

FANUC’s products are used in a wide range of industries including automotive, aerospace, consumer goods, e-commerce, food and beverage, medical device and pharmaceuticals to name a few. The company’s line of painting robots, and a variety of automation software products have been designed and built in Michigan since 1982. (www.fanucamerica.com)

Yaskawa Motoman
CELEBRATES 30-YEAR ANNIVERSARY

The Motoman Robotics Division of Yaskawa America, Inc. (Yaskawa Motoman) recently celebrated its 30th anniversary.

Previously known as Motoman, Inc., the company was incorporated on July 18, 1989 as a 50/50 joint venture between Hobart Brothers Company and Yaskawa Electric America, and officially began operations on August 1, 1989. In 1994, Motoman Inc. became a wholly-owned subsidiary of Yaskawa Electric Corporation (Kitakyushu, Japan), a worldwide leader in mechatronics and robots.

The company started with just 59 employees and now has nearly 700 employees serving from 11 strategically placed facilities throughout the Americas. Employees are committed to complete customer satisfaction and remain dedicated to delivering high quality innovative robotic solutions that help customers and partners compete globally. Yaskawa Motoman is also committed to supporting the nation’s STEM initiatives and promoting the use of robotics for education and workforce development.
“This is an incredible milestone for our company,” offered Steve Barhorst, Yaskawa Motoman’s president and COO. “The hard work and dedication of talented team members has enabled us to constantly push the boundaries of innovation and provide the highest level of customer satisfaction in the automation industry.” (www.motoman.com)

Cloyes Gear
MAINTAINS MANUFACTURING EXCELLENCE WITH ARKANSAS PLANT PURCHASE

After opening its Paris, Ark., manufacturing plant in 1963, Cloyes Gear and Products announced it has successfully regained ownership of the manufacturing operation from American Axle & Manufacturing (AAM). AAM held ownership of the plant following its 2017 acquisition of Metaldyne Performance Group Inc. (MPG), which included Cloyes. In April 2018, Hidden Harbor Capital Partners, an operationally focused private equity firm specializing in control investments in lower middle market companies, acquired Cloyes and immediately started the process of purchasing the Paris plant to continue Cloyes’ nearly 100-year-old manufacturing history in the United States.

“Cloyes came to Paris in 1963 and has been a big part of the town’s economy for more than 56 years. Many of our employees have worked for Cloyes their entire adult life and have more than 30 years of seniority with the company,” said Steve Fairbanks, vice president of manufacturing for Cloyes.

Continental
HOSE PLANT RECEIVES SANITARY STANDARDS CERTIFICATION

Continental’s industrial hose plant here has received a major sanitary standards certification from the independent U.S. organization 3-A SSI for a selected range of food and beverage hoses.

Based in McLean, VA, the 3-A SSI is an independent, nonprofit organization that leads the development of standards for equipment and accepted practices for processing systems through a modern consensus process based on ANSI (American National Standards Institute) requirements. The company represents the interests of regulatory sanitarians, equipment fabricators and processors in “Promoting food safety through hygienic design.”

The certification No. 3727 and the designation 18-03 (for rubber and rubber like materials) received by Continental’s Granby plant places them in a unique category. “There is a distinct difference between compliance and certification,” said Laszlo Dobo, Continental’s product manager for industry hoses in North America. “Anyone can claim ‘compliance,’ but certification comes only from an independent organization. 3-A SSI has very strict standards because they represent the end-users and the public. They provide special knowledge resources on hygienic equipment design to enhance professionalism and to serve the public health sector.

Continental’s Granby plant manufactures industrial hose on special mandrels for a variety of markets including dairy, wine, breweries, food processing and beverage. The facility is located about an hour east of Montreal and supports a global market. (www.continental.com)
If you’ve never attended IFPE and the co-located CONEXPO-CON/AGG at the Las Vegas Convention Center, prepare to be overstimulated by the sights and sounds of the construction, fluid power and power transmission industries. This show is BIG. So much so that the parking lots surrounding the convention center are repurposed as additional outdoor exhibit halls. Need a crane? Need hydraulics? Need pneumatics? Need an excuse to spend five days in Las Vegas? You’ve come to the right place!

IFPE is the leading international exposition and educational resource dedicated to the integration of fluid power with other technologies for power transmission and motion control applications. Held every three years, the next IFPE is set for March 10–14, 2020.

**Who Should Attend?**
The IFPE show attracts design engineers and other decision-makers from industries including off-highway vehicles (includes construction, mining, forestry, agriculture, lawn and garden, and airport support vehicles), fluid power/power transmission products, electrical machinery, instruments/controls, distribution, material handling (includes overhead/straddle cranes, industrial trucks, tractors and stackers), manufacturing/production automation/machine tools (includes chemical, petroleum, metal, plastics, and rubber processing), automotive/commercial vehicles (includes Class 8 trucks, vocational trucks, and trucks for other applications), engineering services, defense/aerospace, and amusement/entertainment technology.

IFPE exhibits showcase the latest technologies and innovations in equipment, products and services for fluid power/motion control/power transmission. The show also features product-focused exhibit pavilions and international exhibit pavilions. IFPE is owned by the National Fluid Power Association (NFPA) and the Association of Equipment Manufacturers (AEM). AEM is show producer.

**Educational Opportunities**
“AEM and the National Fluid Power Association are proud to bring together a unique combination of engineers and executives at IFPE 2020, both in booths and in aisles, to share ideas, educate one another, and ultimately shape the future of the construction industry through collaboration and consensus,” said John Rozum, director, ag events at AEM and IFPE show director.

For many attendees, part of the IFPE show experience includes participation in IFPE’s education program, including college courses and timely sessions to help them stay on top of their game.

New this year, attendees will be able to mix and match sessions between both IFPE and CONEXPO-CON/AGG. Attendees will be able to pay one price and select education from both shows. Presenters for IFPE’s education sessions come from across the United States from distinguished universities.

To add to the great education sessions and the over 400 exhibitors, in 2020 IFPE will be hosting for the first time a special networking reception for engineers and executives, right on the show floor. The IFPE’s Fluid Power Hour, presented by Bosch Rexroth, will be held on March 11th from 4 p.m. to 6 p.m. on the IFPE show floor. The event includes a bonus hour on the IFPE show floor, complimentary hors d’oeuvres and cocktails and entertainment.

“We encourage all exhibitors to bring their top engineers and executives to take advantage of a great networking experience and interact with industry peers,” said Rozum.

Attendees at the 2020 shows can take advantage of more than 180 education.
sessions packed with timely information, developed with the guidance of leading industry groups, and delivered by industry experts.

“The line-up of programming is not only larger than it has ever been but includes a fresh line-up of speakers stacked side-by-side with core programming that is always highly attended,” said Eileen Dickson, vice president education, National Ready Mixed Concrete Association and CONEXPO-CON/AGG Education Committee chair.

CONEXPO-CON/AGG 2020 education tracks will offer the latest trends and best practices focused on: aggregates; asphalt; concrete; cranes, rigging & aerial lifts; earthmoving & site development; equipment management & maintenance; business management; and safety, plus technology solutions and attracting, engaging and retaining talent.

“The education committee took great care in putting together a program that grows attendee knowledge on building their business on all fronts, whether the technical skills needed in the field or best practices to build their business,” said Graham Brent, CEO of the NCCCO Foundation and CONEXPO-CON/AGG Education Committee vice chair.

CONEXPO-CON/AGG 2020 education includes:

- Driving New Innovation at Complacent Companies - James Benham, JB Knowledge
- Drones on Construction Sites for All Contractors - Ryan Murguia/Zach Pieper, Quantum Land Design
- Gain a Competitive Advantage Through Construction Technology - Tauhira Hoossainy, Milwaukee Tool
- How to Win the War for Talent - Gregg Schoppman, FMI
- Technology Trends: Lessons Learned - Helga Jacobsen, United Rentals
- Top 10 Reasons Why Construction Businesses Fail - Larry Kokklenberg, Center for Business Development

IFPE Education – Focused on Fluid Power

IFPE education is grouped in two tracks:

- Hydraulics & Pneumatics at Work
- The Business of Fluid Power

IFPE 2020 education includes:

- Additive Manufacturing - Vince Anewenter, Milwaukee School of Engineering
- Industry of the Future - Prasad Ganorkar, McKinsey & Company
- IoT – Sharing Data Across Customer Boundaries - Adam Livesay, Elevat
- Mobile Hydraulic Robotics - Autonomous Machines - Chris Woodard and John O’Neill, Danfoss
- Workforce Development - Lynn Beyer, NFPA

The IFPE Research Symposium is hosted by IFPE co-owner National Fluid Power Association (NFPA) and runs during lunch (11:30 am–12:30 pm) March 11–13. Sessions will showcase the latest fluid power research at U.S. universities being funded by the U.S. Department of Energy to improve energy efficiency of off-road vehicle hydraulic systems.

“We focused on developing education programs that offer attendees the latest ideas and innovations in fluid power technology, applications and research. Our classes and sessions deliver critical information for engineers and others involved in the design and manufacturing process,” said Eric Lanke, president/CEO, NFPA.

IFPE 2020 education includes:

- Additive Manufacturing - Vince Anewenter, Milwaukee School of Engineering
- Industry of the Future - Prasad Ganorkar, McKinsey & Company
- IoT – Sharing Data Across Customer Boundaries - Adam Livesay, Elevat
- Mobile Hydraulic Robotics - Autonomous Machines - Chris Woodard and John O’Neill, Danfoss
- Workforce Development - Lynn Beyer, NFPA

More to Come

IFPE booth previews, product spotlights and new technologies will continue to be a part of PTE’s online editorial coverage in the coming months. Come back early and often to see what’s new in power transmission and motion control for the fluid power and construction industries. PTE

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January 6–10—SciTech 2020 Orlando, Florida. From its creation in 1965, the American Institute of Aeronautics and Astronautics (AIAA) has organized conferences to serve the aerospace profession as part of its core mission. Spanning over 70 technical discipline areas, AIAA’s conferences provide scientists, engineers, and technologists the opportunity to present and disseminate their work in structured technical paper and poster sessions, learn about new technologies and advances from other presenters, further their professional development, and expand their professional networks that furthers their work. Five focus areas include science and technology, aviation, space, propulsion and energy/defense. For more information, visit scitech.aiaa.org.

January 13–15—A3 Business Forum 2020 Orlando, Florida. The Association for Advancing Automation (A3) Business Forum is the world’s leading annual networking event for robotics, vision & imaging, motion control, and motor professionals. Over 650 global automation leaders attended the 2018 show. The event includes keynote and breakout sessions on the human exploration of Mars, a global economic outlook, automation market update, trends in robotics, responsible artificial intelligence and others to be announced. Networking opportunities include a golf scramble, a wellness walk, and a first timer’s reception. For more information, visit www.a3automate.org.

January 24–25—EASA Principles of Medium and Large AC Motors Cincinnati, Ohio. The seminar and its companion manual have been developed by Austin Bonnett, EASA’s education and technology consultant, in collaboration with EASA’s Technical Support Specialists and members of EASA’s Technical Education Committee. While the course covers horizontal and vertical squirrel-cage induction motors in the 300 to 5,000 horsepower range, low and medium voltage, most of the principles covered apply to other sizes as well. This seminar focuses primarily on NEMA motors. Highlights include motor theory, applications, safety, root cause failure, testing, vibration/noise and more. EASA Members ($489 per person) Non-Members ($589 per person). For more information, visit easa.com.

January 28–30—AGMA Gear Manufacturing and Inspection Garden Grove, California. Attendees will discover key factors in the inspection process that lead to better design of gears, develop a broad understanding of the methods used to manufacture and inspect gears and interpret how the resultant information can be applied and interpreted in the design process. The class will be from 8:00 am–5:00 pm each day. This course also includes a tour of Western Precision Aero in Garden Grove, CA. Participants will be required to fill out paperwork prior to the tour and must be US citizens. AGMA will distribute the paperwork upon registration. Gear design engineers, management involved with design, maintenance, customer service, and sales should consider attending the event. Ray Drago, chief engineer of Drive Systems Technology, Inc., will be the instructor. For more information, visit www.agma.org.

January 28–30—IPPE 2020 Atlanta, Georgia. The International Production & Processing Expo is the world’s largest annual poultry, meat and feed industry event of its kind. A wide range of international decision-makers attend this annual event to network and become informed on the latest technological developments and issues facing the industry. Combining the expertise from the American Feed Industry Association, North American Meat Institute and U.S. Poultry & Egg Association, IPPE will also feature more than 200 hours of dynamic education sessions focused on the latest industry issues. The International Production & Processing Expo (IPPE) is a collaboration of three shows — International Feed Expo, International Meat Expo and the International Poultry Expo — representing the entire chain of protein production and processing. For more information, visit ippexpo.org.

February 3–7—World of Concrete 2020 Las Vegas, Nevada. Original equipment manufacturers from around the world and exclusive U.S. distributors of equipment, tools, products and services for the commercial construction, concrete and masonry industries attend World of Concrete. The show attracts approximately 1,500 exhibitors and occupies more than 700,000 net square feet of indoor and outdoor exhibit space. World of Concrete is the premier event for the commercial construction trades. Education tracks include engineering, safety and risk management, general business, business and project management and concrete 101. Interactive workshops include trainer training, construction boot camp, sales and more. For more information, visit www.worldofconcrete.com.

February 18–20—AGMA Fundamentals of Worm and Crossed Axis Helical Gearing Alexandria, Virginia. Provides an introduction and emphasize the differences between parallel (the experience base) axis and worm and crossed axis helical gears. Describe the basics of worm and crossed axis helical gears, their fundamental design principals, application guidelines and recommendations, lubrication requirement, a discussion of accuracy and quality and summarize with a brief review of common failure modes. Class will take place at AGMA Headquarters and class times will be 8:00 am–5:00 pm each day. The course will be instructed by William “Mark” McVea, president and principal engineer at KBE+, Inc. For more information, visit www.agma.org.

March 7–14—IEEE Aerospace Conference 2020 Big Sky, Montana. The International IEEE Aerospace Conference, with AIAA and PHM Society as technical co-sponsors, is organized to promote interdisciplinary understanding of aerospace systems, their underlying science and technology, and their application to government and commercial endeavors. The annual, week-long conference, set in a stimulating and thought-provoking environment, is designed for aerospace experts, academics, military personnel, and industry leaders. The 2020 conference is the 41st in the series. Conference topics include aerospace systems, military, civilian or commercial aerospace endeavors, government policies, aerospace engineering and management, and more. The event features over 175 hours of technical sessions and 20 hours of networking events. For more information, visit aeroconf.org.
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*Your PRIVACY is important to us. You get to CHOOSE how we use your personal information. The next e-mail we send you will have clear instructions.
Andries Keyser built his first steam locomotive at the age of 19 and completed the project five-years later. It was named after his mother, Doreen and is based on a Beira Railways Lawley design from way back in 1895. Since then, he has built a variety of coaches, three electric engines and restored a UVE, steam engine named after his mother-in-law this time (Anna).

Now his team (that was awarded the Guinness World Record in 2017 for the longest distance covered by a miniature steam train) is setting its sights on improving its record.

Keyser Locomotive Works, together with the Pietermaritzburg Model Engineering Society, in South Africa, was able to cover 330 km in 24 hours in its record-breaking attempt, which outstripped the previous 1994 record of 269 km covered in 24 hours.

It did so for many reasons, one of which was the self-lubricating Vesconite polymer bushings that were fitted to the connecting and coupling rods.

These internal, hard-to-reach turning components did not need to be oiled, and this helped reduce stopping times during the record attempt.

“You can’t oil these bushings on the run,” says Keyser.

This was not the case with many of the original bronze bushings that had to be oiled every hour when the locomotives stopped and the drivers were changed.

Six of the main crank bushings are currently made from Vesconite polymer bushings on the record-breaking locomotive named Doreen, but the intention is to replace all the bushings with Vesconite eventually to reduce oiling requirements in future record-breaking bids.

“The Vesconite has no heat expansion and, using a sloppy fit, didn’t heat up at all,” Keyser notes. “The engine output was not compromised in any way and still runs today on the same bushes, two years and many kilometers later,” he says.

Another innovation that will assist Keyser to further improve the record is the fact that he is building the longest straightest track that he can in the Stellenbosch Winelands, in South Africa. This will enable the locomotive to run at higher speeds on a track gauge of only 184 mm.

Known as the Winelands Light Railway, Keyser is establishing a theme park with 1/3-scale trains, matching buildings, bridges and tunnels, and a hobbies expo for locomotive enthusiasts once a year. Presently there are four steam and one electric locomotive in the engine shed, with 13 wagons able to haul up to 50 people per train. Everything is handmade and based on narrow-gauge prototypes from all over the world.

Starting on December 14, 2019, the park will be open on weekends, public and school holidays if the weather allows. This unique attraction aims to become the biggest family-friendly destination in the Western Cape within the next 10 years.

Keyser will make another world-record attempt sometime in the future and expects that between 30 and 60 km will be added to the current distance record.

You can follow his steam train adventures here (www.facebook.com/keyserlocomotiveworks/?__tn__=CR) and learn more about the Vesconite bushings here (www.vesconite.com). PTE
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