

Bearing NEWS

2017

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ISSUE 08

BEARING INDUSTRY MAGAZINE

THE BEARING PLANT OF THE FUTURE

PREPARATION AND APPROACH TO
BEARING DAMAGE ANALYSIS

HOW TO MANAGE HOT
BEARINGS IN YOUR PLANT?

WHAT TO EXPECT FROM
CHINA'S BEARING STEEL INDUSTRY

TOP10 TIPS
FOR BEARING RELIABILITY



REGAL
MASSIMILIANO VALENTINO



SKF
MARTIN JOHANNSMANN



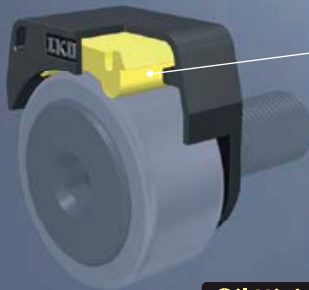
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RELIABILITY
CONFERENCE
& EXPO
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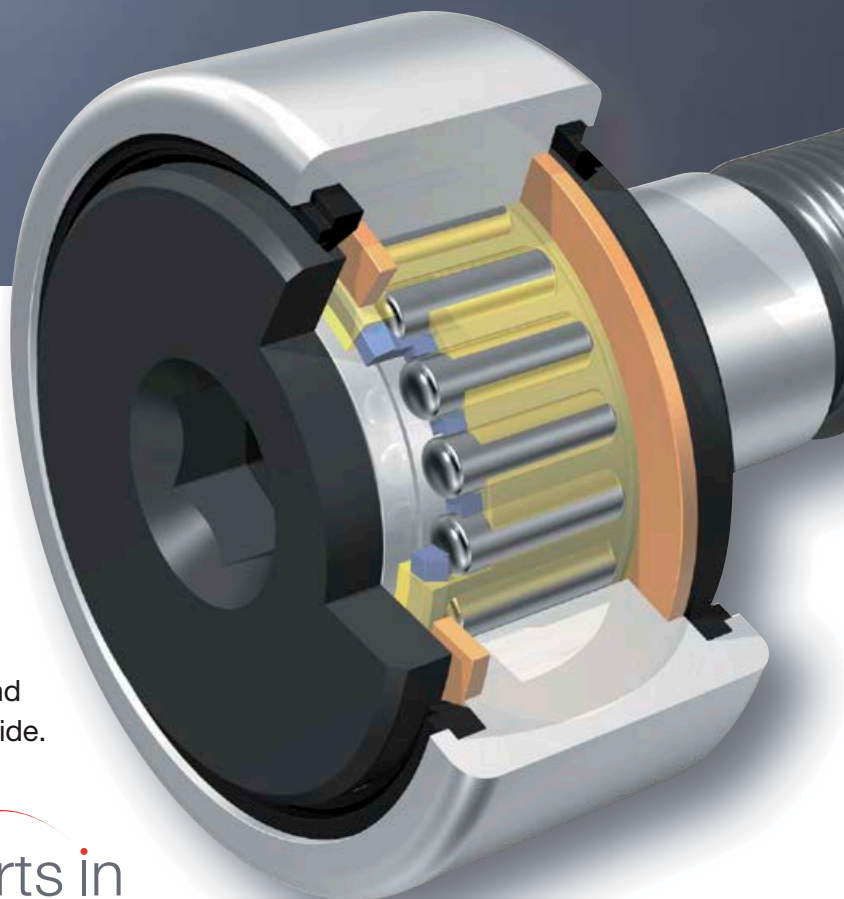


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2nd Edition of The Bearing Reliability Conference and Expo

Due to the great success of the of the Bearing Reliability Conference & Expo event that ran on 22 – 23 March 2016 and the request of many participants to run it again, the agenda is set for 2017. The 2017 edition of the BRCE conference and expo will cover 3 days in the Westfalenhallen Dortmund, with free access to the networking and expo area including 8 unique workshops; beside the 4 keynote and 16 speaker presentations with focus on the bearing and reliability competences; in the conference area. With it's 3 days 'bearing knowledge & networking concept, the organizations aims to become the most important event for engineers, end-users, OEM equipment manufacturers and bearing industry professionals to make their bearing and assets more reliable. You can read the full agenda and details of this great event on page 73.

The bearing is an essential element and the rotating heart of all machines and if it fails or malfunctions, then so does the machine or equipment. The lubrication can be considered as the blood of all machines and a crucial element of machines conditions and overall production efficiency. We tried to summarize the solutions for frequently asked questions such as "Which lubricant do I use for this bearing?", "What is the calculated maximum amount?", "How frequently should we check this bearing?". You can read in this issue the vital role of lubrication for bearing performance and life, the parallel paths of maintenance and lubrication, a case study about lubrication of rolling bearings on a paint shop ventilation fan and the details of an unique system for improved lubrication practices.

Further in this issue, we have 'a BearingNEWS classic' four exclusive interviews with the leaders of leading production and distribution organizations in the bearing industry. The first interview is with Massimiliano Valentino, The Vice-President Europe of REGAL. We had the chance to discuss with him REGAL's power transmission solutions in Germany, their expansion strategies and how to handle the increasing pressure in expectations to reduce cost while maintaining or even improving quality by adoption of more efficient manufacturing procedures and logistics efficiency.

The second interview is with Thomas Ammerpohl, Sales Manager Industrial Aftermarket of NACHI Europe. We had a nice conversation with him about the European market, innovations in bearing technology and NACHI's efforts to grow market shares.

Just a few weeks ago, SKF has opened its "Sven Wingquist Test Center", which is one of the world's most powerful large-size bearing (LSB) test facility. In our third interview, Martin Johannsmann, CEO of SKF GmbH explains the motives for the 40 million euro investment at the company's Schweinfurt site and how SKF customers can profit from it.

Our fourth interview is with George 'Sandy' Thomson, who has, as is tradition, handed the company reins down to a younger family member (step-daughter Anna Galoni), he still has an important role to play in the family-owned Thomson-Gordon Group, the Canada-based parent of Thordon Bearings. His business card reads simply "Innovator". You can read his journey at Thordon Bearings in "A portrait of the artist as a young man".

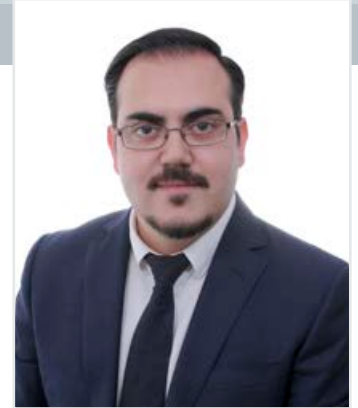
What's rolling in the bearing industry? A brief summary of what happened during the last six months in the bearing industry; preparation and approach to Bearing Damage Analysis; How to manage hot bearings in your plant?; a new volume of top 10 bearing reliability tips from Per Arnold Elgqvist and what to expect from China's bearing steel industry...Together with all these interesting topics, many other bearing industry related articles, insights and developments can be discovered in this September issue of the BearingNEWS magazine.

160 pages full of BearingNEWS, We hope that you will enjoy it!

Kenan M. Özcan

Editor in Chief

BearingNEWS



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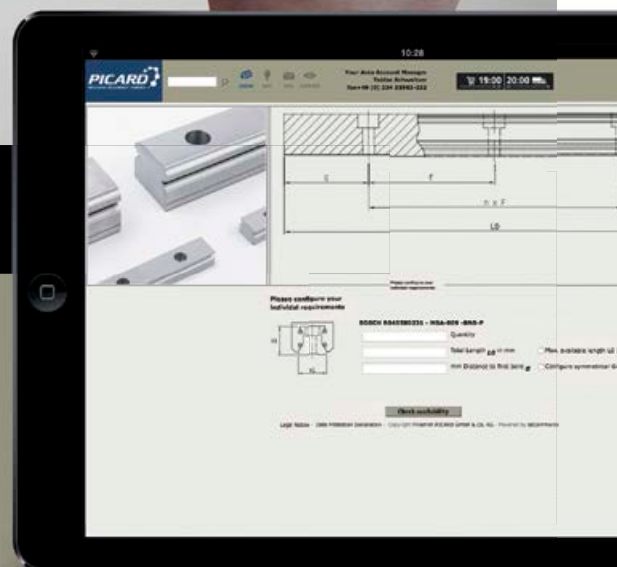
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2nd Edition of BRCE
will be held from 10 to 12 October 2017
The Bearing and Reliability Conference & Expo

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BEARING RELIABILITY CONFERENCE &
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AFTER 110 YEARS, BASIC RESEARCH IS STILL GOING AT
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MAXIMIZE ELECTRIC MOTOR BEARING LIFE
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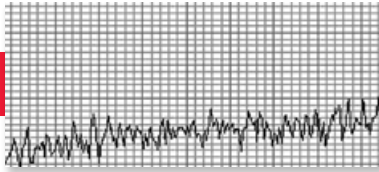


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**FREE
WORKSHOP
FOR VISITORS**

**BEARING
FAILURE
ANALYSIS**

Presented by
PER ARNOLD ELGQVIST

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NTN-SNR'S PLANT OF THE FUTURE

READY FOR ORDERS TO TAKE OFF



NTN-SNR was present at the International Paris Air Show in Le Bourget from 19 to 25 June, in battle formation, ready to meet orders placed under the major contracts signed for the supply of bearings for CFMI LEAP engines, Pratt and Whitney NGPF engines and Rolls Royce Trent 1000 and 7000 engines. As a result, a €27 million investment called "Take Off" was initiated for the extension and modernization of the Argonay production site (France). This production site solely produces bearings for aviation. This new cutting-edge plant already started producing the first parts. This investment includes robots, best in class machines for grinding, complex machining and heat treatment, implementation of a MES (Manufacturing Execution System), and ergonomic workstations. The investment will continue in stages through 2018. In

addition, NTN-SNR is working on bearings which will be used in the transmission of the new Airbus Helicopter X6. It is also compulsory for the new production site to obtain customer certification, which will enable it to start the LEAP bearing maintenance and repair market, in addition to developing a R&D programme for powder metallurgy.

Tomorrow's plant for today's engines

NTN-SNR's Take-off project will enable it to offer a site at the cutting edge of technology and productivity, enabling them to meet the quality requirements and order volumes generated by the new contracts signed. It is a genuine plant of the future for producing the bearings for the LEAP engines produced by CFMI (a joint venture between GE and SAFRAN),

Pratt and Whitney NGPF engines, and Rolls Royce Trent 1000 and 7000 engines. Almost 70% of the investment is going into machines for heat treatment (case hardening, vacuum treatment and nitriding), grinding, complex machining, a new breakthrough technology for roller production, metrology, automating certain processes and non-destructive testing. The Lean method has been applied to range optimisation, line design, and workstation ergonomics, with both physical and cognitive workspace rating during the design phase. This approach, together with advanced employee training, reduces





the throughput time of parts under production to support the increased production rates that will be imposed by the new programmes. Another major aspect in satisfying the demands of these contracts is the complete traceability of the parts produced, which is provided by a MES. Finally, to ensure the best possible mechanical stability of the parts during production, the new building complies with strict thermal constraints, with variations of no more than 1°C per hour over 3,800 m².

New markets, new innovation programmes

NTN-SNR has signed several contracts to provide bearings for CFMI's LEAP engines, Pratt and Whitney's NGPF and Rolls Royce's Trent 1000 and 7000. In addition, NTN-SNR has secured its long-standing relationship with Airbus Helicopters by being selected to develop the transmission

bearings for the X6 helicopter, which is set to replace the Super Puma. NTN-SNR also has its sights on the significant maintenance and repair market for LEAP engine bearings, and is implementing the processes that will enable it to obtain customer certification. NTN-SNR has been involved in this market for 25 years, through its work on the bearings for the CFM56 engine.

NTN-SNR has always invested heavily in innovation, particularly in the aviation sector. One of the new areas of research is powder metallurgy. This new technology is very promising with a view to obtaining steel capable of withstanding larger loads for the same overall dimensions, due to greater hardness and improved fatigue resistance. The company is working in this area with Aubert and Duval, a well-known French steelmaker in the aviation world, which will also be exhibiting at Le Bourget.



Photos: PEDRO STUDIO



WORLD'S BIGGEST

INDUSTRIAL BEARINGS

3
MILLION
DESIGNATIONS
FROM

**INTERCHANGE
SYSTEM**



Bearing Data's Interchange System – overview

Bearing Data is the most comprehensive and reliable database of industrial bearings interchange and aims to become a global reference.

More than 3 million bearing designations are available in Bearing Data's database,

providing roughly 200,000 interchange reports from more than 100 of the most important bearing manufacturers worldwide.

In using Bearing Data, you can find several alternative brands for your bearing applications, coupled with a detailed explanation of prefixes and suffixes for all bearing designations, as

well as cage material.

You can conduct searches by simply entering the bearing designation you wish to find cross-references for, and then receive a clean, precise report. It is also possible to print and save reports. You can also use the report for a quotation request, purchase request or even for detailed inventory control.

"200,000 interchange reports from more than 100 of the most important bearing manufacturers worldwide."

This product is the result of eight years of research on the part of engineering professionals with experience in many application fields who made this database project possible.

At Bearing Data, you'll find standard bearings as well as bearings specifically designed for special applications. In terms of special applications, you can find bearings for high temperatures, electrically insulated bearings, bearings with special coatings, sealed bearings, ceramic bearings, corrosion-resistant bearings, split bearings, precision bearings, energy efficient bearings, special and large size bearings for the steel, paper and mining industries.

Benefits of the Interchange System

Bearing Data's Interchange Reports match different manufacturer part numbers you may have in stock, thus reducing duplicate inventory, eliminating unnecessary purchase expenses, delivery waiting time and avoiding unplanned downtime.

In just a few seconds, you'll have all possible alternatives and can select best-fit based on the detailed specifications provided in our reports, as well as even optimize design cost. Finding options from alternative brands is another advantage of the system.

Bearing Data's database is updated on a monthly basis.

Easy to use

The tool is easy to use and requires no training.

By entering information about a bearing (bearing designation, dimensions, clearance, tolerance, preload and manufacturer), Bearing Data will generate a detailed report for your search. You can also do searches by looking for a specific bearing type or for a specific bearing application. At Bearing Data, you will find more than 600 bearing types in order to

obtain the best option for your particular application.

Bearing Basket

Another Bearing Data feature is the Bearing Basket, which is a very simple tool that helps you find the bearing you need.

How does it work? Quite simple. Enter the data regarding the bearing you're looking for (designation, quantity) and the part number will be uploaded into the Bearing Basket, which is a list of bearings on demand. The distributor with the respective bearing in inventory will send a quotation directly to your email. You may find more information about this tool on Bearing Data's homepage.

Summary

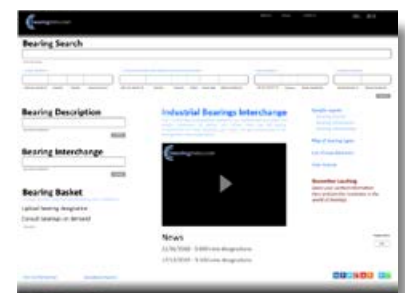
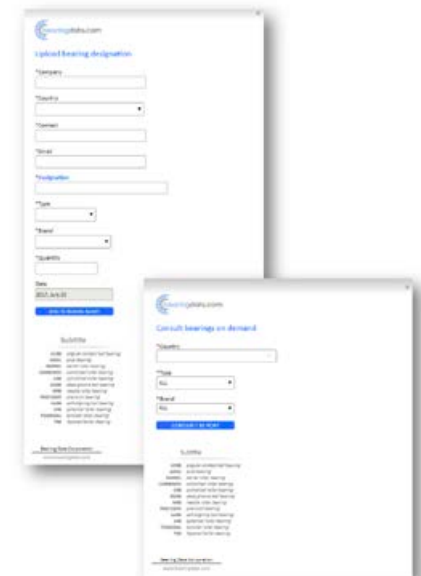
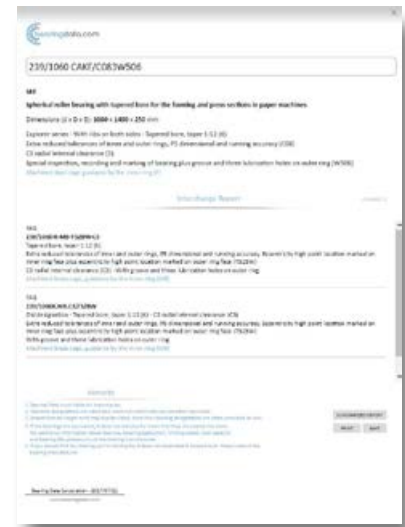
- 3 million bearings in the interchange database (radial bearings, precision bearings, axial bearings and combined bearings)
- Over 600 bearing types listed
- More than 100 manufacturer part numbers listed
- Search by part number, dimensions, bearing type or manufacturer
- Prefix and suffix descriptions
- Simple to use, no training required
- Easy and intuitive
- Comprehensive and reliable

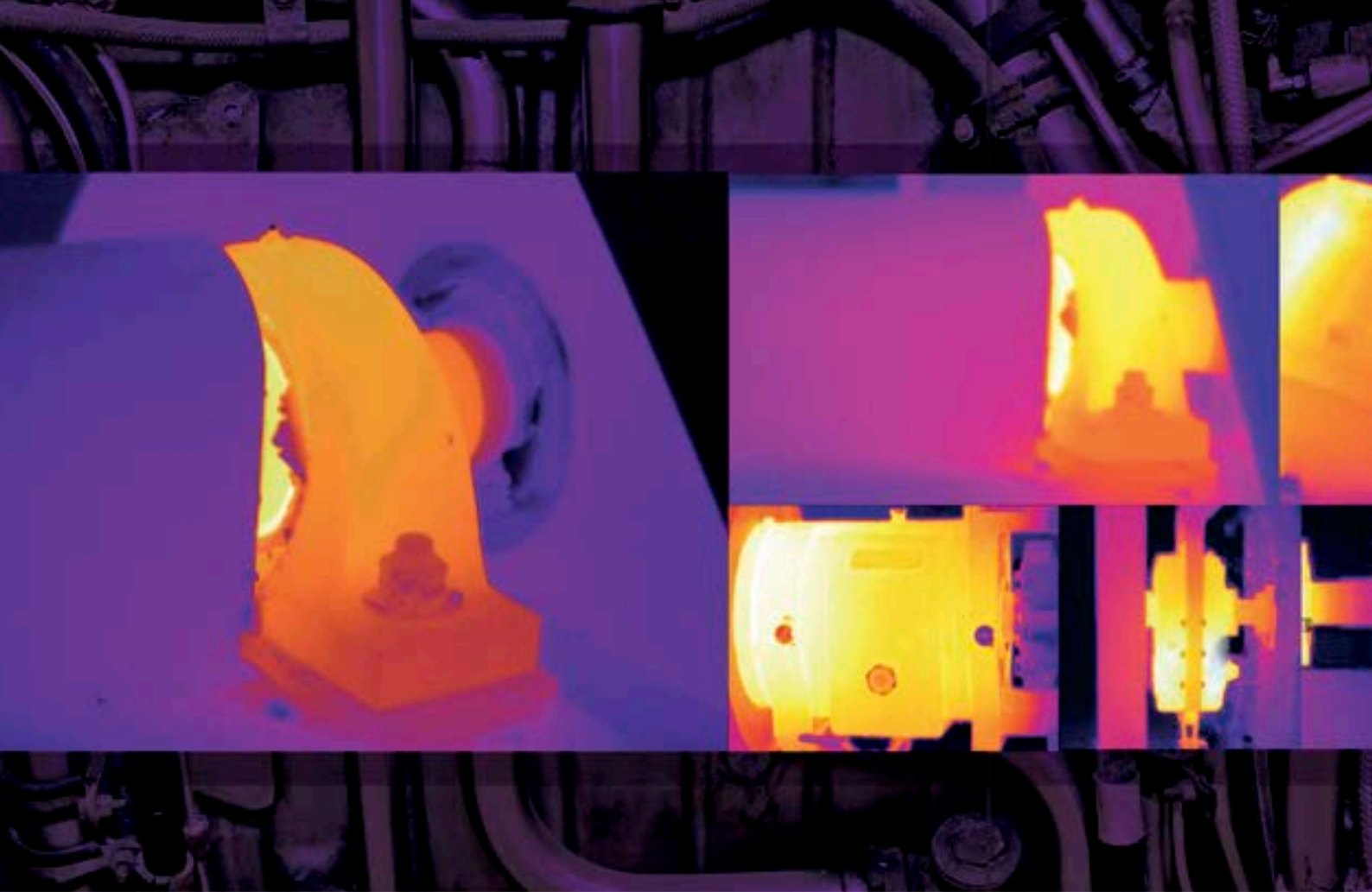
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- List of manufacturers
- User manual

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HOW TO MANAGE HOT BEARINGS IN YOUR PLANT?

BEARING TEMPERATURE CONDITION MONITORING

Author: Randy Riddell, SCA

After making his equipment-care rounds, a maintenance technician has discovered that several bearings are “running hot.” These bearings are added to a list for some form of action. A work order may be written to change the bearings, or someone may put cooling water on the bearing housings. Even if the actual bearing temperatures are known, often times no one truly understands what actions are required at which temperatures.

Measuring Bearing Temperatures

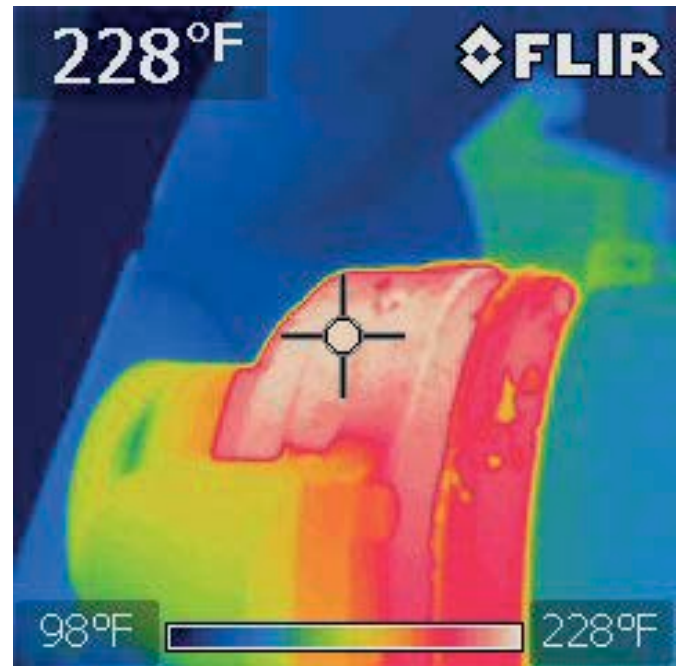
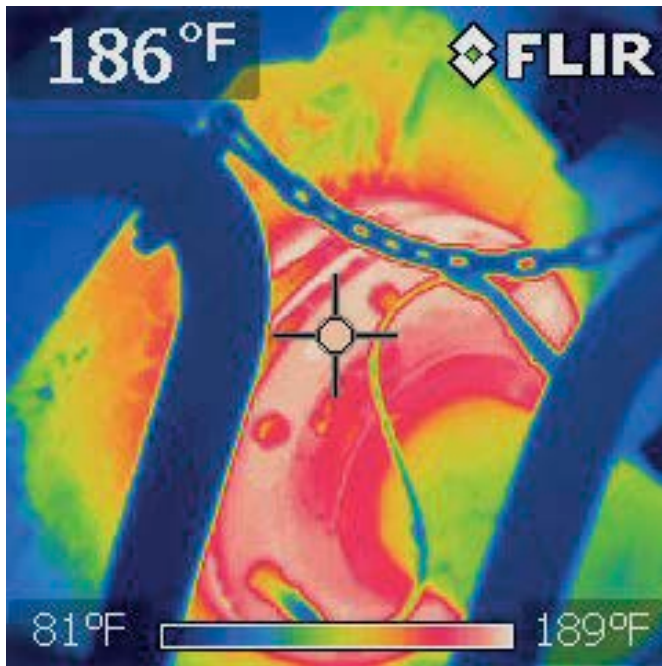
Before any action is taken, the question of how hot the bearing is should be answered. Hot to the touch might only be 130 degrees F, as 120 degrees F is

generally the threshold temperature where you can still hold your hand on the surface. While there may be gray areas for identifying the appropriate action at certain temperatures, some guidelines can provide consistency and help plant personnel make better decisions.

“Keep in mind that the temperatures measured are only the skin temperatures of the bearing housings.”

The first step should be to determine the actual temperature of the bearings being monitored. Keep in mind that the temperatures measured are only the skin temperatures of the bearing housings. The actual bearing temperatures will be 15-25 degrees hotter. Observe the surface condition and type when measuring temperature. Also, ensure the measuring device’s emissivity is correct for the surface being measured. Most dark carbon-steel surfaces will have an emissivity setting around 0.95, while shiny stainless steel or aluminum will have a much lower setting. A typical infrared camera shot is shown below.

Process buildup on bearing housings can result in lower measured temperatures



An infrared image of a bearing housing

when the actual bearing temperatures are much hotter. Buildup will insulate the bearing and not allow it to dissipate heat, which will in turn make the bearing run even hotter. Temperature checks should be performed in the same locations on the equipment and the bearings. Variations in bearing temperatures can be expected when different locations are measured due to load zones, ambient temperatures, lube levels, etc. Consistency is also important when different individuals are taking the measurements.

Bearing Temperature Conditions

Most precision installed and lubricated equipment will operate at less than 180 degrees F. A bearing temperature that is less than 180 degrees F is typically considered acceptable (see the chart below). Of course, there may be other consequences for operating in this “good” range. A higher operating temperature will cause the bearing lubricant to deteriorate at a faster rate. At more than 150 degrees F, the lubricant life can be cut by 50 percent for every additional 18 degrees F. A higher operating temperature also means a lower operating viscosity for the lubricant, which may hurt the overall reliability of the equipment. The diagram below shows how the maximum temperature for a specific lubricant (viscosity index) and bearing type may limit the

maximum operating temperatures.

Caution Conditions

In a caution condition, the bearing temperature may be between 180 and 200 degrees F. While this is slightly higher than desired, it may be a typical operating temperature for some equipment. Therefore, it is essential to have an operating temperature history for equipment in this range to determine if the temperature is normal. For gearboxes, sump temperature limits are less than 200 degrees F, as defined by the American Gear Manufacturers Association (AGMA). A C3 clearance bearing is typically considered for this operating temperature. Continue regular monitoring and watch for any significant changes in temperature.

Another factor that is just as critical as the absolute bearing temperature is a change in temperature, which is an indication of a condition change. A temperature change of more than 50 degrees F is of concern no matter what condition range in which the absolute temperature falls. Increased monitoring and investigating should be required with this type of change.

Small temperature changes are generally of little concern. It may be normal for a recently greased bearing to increase in temperature 25-30 degrees

F. Machine speeds and loads as well as ambient conditions (winter/summer) will also affect absolute temperatures. Other factors that can cause higher temperatures include increased bearing friction (poor lubrication, high load, high speed, etc.), excessive lubrication (grease overpressure), high oil level (oil churn) and misalignment.

Alert Conditions

In an alert condition, the bearing temperature may be between 200 and 250 degrees F. These elevated temperatures may be due to a heated application, a recently greased bearing, oil level issues, early stages of bearing failure, etc. Be sure to verify the process conditions, recent greasing cycle or oil level. You may also need to increase the frequency of monitoring the temperature changes. The safe operating temperature for grease is typically 75 percent of the dropping point. If the bearing is running in an application with heat through the journal, this elevated temperature range may be normal for operation. This would also call for a C4 clearance bearing.

Alarm Conditions

In an alarm condition, the bearing temperature may be between 250 and 300 degrees F. Bearings operating in this temperature range likely are in some stage of failure. The amount of life left can be highly variable. Employ

< 180°F GOOD	180-200°F CAUTION	200-250°F ALERT	250-300°F ALARM	> 300°F TRIP/SHUTDOWN
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other predictive technologies (vibration, infrared, ultrasonic testing, etc.) and increase the condition monitoring frequency until corrective action is taken. Also, minimize stress on the bearings by limiting startups/shutdowns and reduce process speed/load changes. Begin preparing a maintenance plan (order materials, define the job scope, etc.) for executing corrective action for either a planned event or unplanned failure. Use care when lubricating any bearing in an alarm condition, as lubricating (especially greasing) can elevate the operating temperature and even lead to failure.

Shutdown Conditions

In an equipment trip/shutdown condition, the bearing temperature may be more than 300 degrees F. Bearings at this temperature are likely in the

final stages of failure. Depending on the equipment design, failure can be rapid and catastrophic. The time to react may only be hours, not days.

At this point, the bearing is gone, so your actions should be focused on minimizing a secondary failure of the remaining components (shaft, housing, etc.). An immediate equipment trip/shutdown may be recommended to prevent catastrophic failure and additional damage.

The bearing integrity and geometry can be severely compromised at this temperature range, as the heat stabilization temperature for many bearings is between 300 to 400 degrees F. Do not attempt to grease a bearing in a shutdown/trip condition, since this is likely to result in an immediate failure.

Cooling Methods

If the bearing temperature is severely elevated, spraying with water could cause it to explode. Do not put water on the bearing or bearing housing. Water can migrate into the bearing and lead to a breakdown of the lubricant film. Corrosion can also occur.

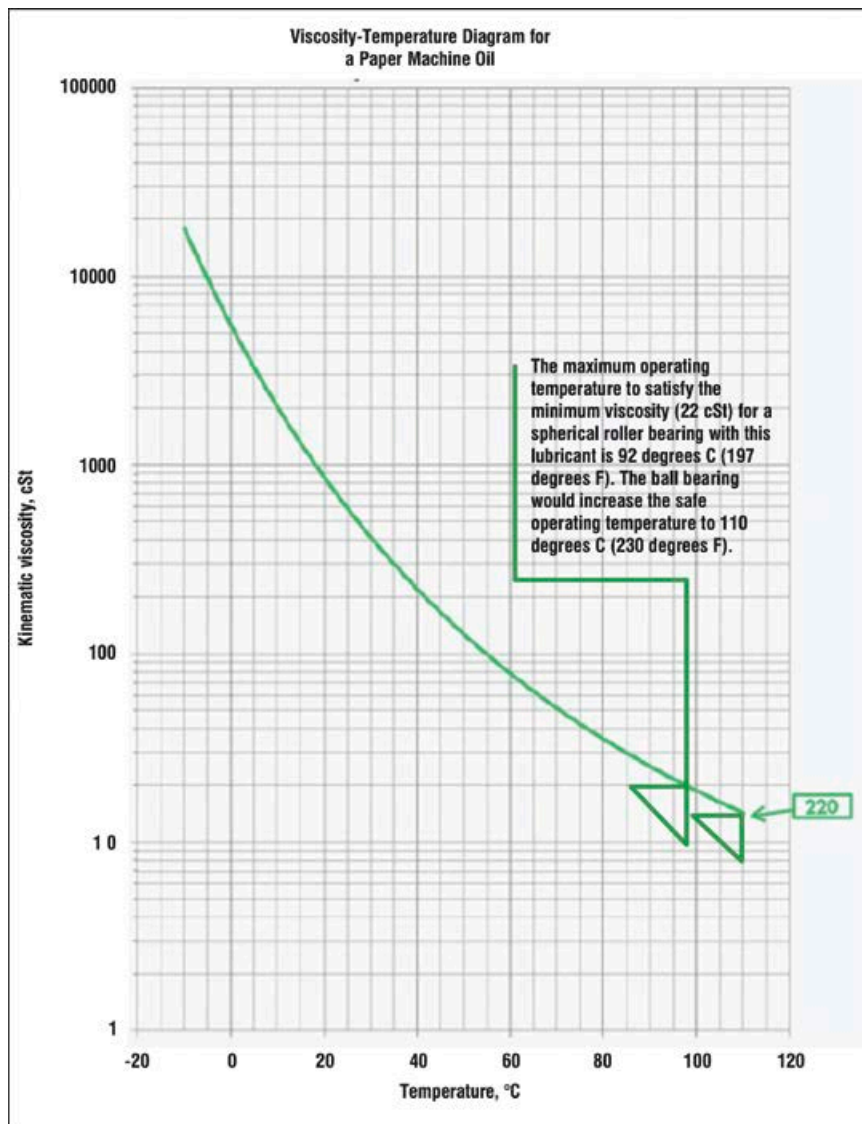
Cooling the housing of a hot bearing can remove bearing clearances when the outer race cools, as the inner race will still be hot. The reduction in radial internal clearance will increase bearing friction and drastically reduce bearing life. The potential of catastrophic failure is also increased. Smaller bearings have a greater risk of this occurring due to their small radial internal clearances.

Using a fan on a bearing housing can be an acceptable cooling method for a bearing in an alert or alarm condition. If the bearing is on a circulating oil system, increasing the oil flow may also cool the bearing. However, too much oil flow can cause oil churn and increased friction inside the bearing.

Expert Help

If a bearing continually operates in an alert or alarm condition, you may need to consult an expert to evaluate the risk of continued operation and to identify possible changes for improvement. These bearings that persistently run at elevated temperatures have a chronic problem and require analysis to determine the root cause.

While bearing temperature monitoring can be relatively simple, the decisions that result will necessitate an evaluation by trained professionals to ensure the best course of action is taken to maximize equipment reliability.



Lube viscosity-temperature curve (Ref. Shell)

About the Author

Randy Riddell is the reliability manager for SCA at the Barton Mill in Alabama. He has more than 25 years of industrial experience with a career focus on equipment reliability. Randy has a bachelor's degree in mechanical engineering from Mississippi State University and is a certified maintenance and reliability professional by the Society of Maintenance and Reliability Professionals. Contact Randy via email at Randy.Riddell@sca.com.



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MASSIMILIANO VALENTINO
REGAL - VICE-PRESIDENT EUROPE

Travelling extensively between the European Regal locations and the US headquarters, we meet Massimiliano Valentino – Vice President Europe – in his Belgian office. Mr. Valentino graduated as Doctor in Electrical Engineering from the University Politecnico di Milano and has embraced the German engineering since his early days. “Germany, home to most premium players in the global automation sector, has become more competitive than it already was. As more OEM’s compete in this market, pressure will be created across the whole value chain. The purchasing functions of the OEM’s will as in the past generate much of this pressure in expectation that the suppliers of all tiers will be able to reduce cost while maintaining or even improving quality by adoption of more efficient manufacturing procedures and logistics efficiency.”

“Regal is ready for the challenge. Innovation is the lifeblood of our business; our products are at the heart of much of the equipment that keeps our world in motion. We strive to produce a constant stream of innovative, value-added products, solutions, and services that provide benefits like improved energy efficiency, variable speed control, embedded intelligence and lower system costs.”

Made in Germany

Being approved by the global leading filling and packaging companies, means you have a solid reputation and know how to work with companies that demand nothing than the best from their suppliers. The foundations of their trust, are in Regal’s corporate values and its history.” Valentino explains: “Flexon was a renowned conveyor chain and belt manufacturer that was acquired by System Plast. Since that day, the production of System Plast® conveyor products has been moved from Italy to Germany; close to the important players in the beverage market. The production capacity increased over the years and 75% has a global destination.”

System Plast® high quality plastic conveyor chains, modular plastic belts and conveying components are well known in the German beverage industry, predominantly in the breweries. This leads us to McGill®, Rollway® and

SealMaster® bearings. The latter has the master of mounted bearings with its SealMaster® PN Gold range; many companies striving for sustainability have found an excellent solution in these lubricated for life bearings.

The bearing solutions are applicable in many industries like construction machinery, packing industry, steel industry and harbor crane production. For the European bearing headquarters in Belgium, their neighboring country Germany is vital. There is a broad portfolio of Rollway ISO standard bearings, while the McGill product line is more focused on cam followers, needle bearings and specialty bearings. SealMaster bearings are your solution when you need premium-quality mounted ball and roller bearings.

“Regal is ready for the challenge. Innovation is the lifeblood of our business; our products are at the heart of much of the equipment that keeps our world in motion.”

Davits and windmills

“In the German marine industry, we are well represented with Rotor nl® electro motors and Jaure® couplings,” explains Valentino. “Rotor nl® motors are manufactured for almost every use you can find in a ship: electric drive propellers, electric motors for propulsion and also motors for pumps, winches and auxiliary services. A leading German shipbuilder for Cruiseliners for instance recently constructed 10 cruise ships for a Chinese customer and all davits - manufactured by d-i davit international-hische GmbH, a renowned German supplier of deck equipment - are equipped with Rotor nl motors. Jaure couplings are made with a wide range of technologies. If you have a very powerful jet application or a windmill from 1 up to 10 MW, Jaure couplings are for you.”

Unico® drive products from Wilnsdorf incorporate application specific features and functions not found in general purpose drives. Whether the customer needs to control a simple machine or a

complex, multi-axis process line, Unico drive engineering orchestrates everything from the motor shaft to the front-office computer. Each system is tailored to the specific requirements of the application.

Strategic expansion

Massimiliano Valentino concludes: “Regal has been expanding a lot in Europe the last decade. The company did several strategic acquisitions and there was an increased demand for tailor-made solutions in key industries. OEM’s tend to step away from the low-cost solutions since they have realized that the cheapest is always the most expensive in the end. We have a broad range of products, strong engineering skills and a great sense of entrepreneurship. I’m confident our team is ready for the next decade.”

If you want to learn more about Regal and its presence in Europe or Germany, please contact Steve Quintijn (steve.quintijn@regalbeloit.com) from the Regal marketing department. He will tell you more about Regal’s increasing presence in the vital markets.

About Regal Beloit Corporation

Regal Beloit Corporation (NYSE: RBC) is a leading manufacturer of electric motors, electrical motion controls, power generation and power transmission products serving markets throughout the world. The company is comprised of three business segments: Commercial and Industrial Systems, Climate Solutions and Power Transmission Solutions. Regal is headquartered in Beloit, Wisconsin, and has manufacturing, sales and service facilities throughout the United States, Canada, Latin America, Europe and Asia.

For more information, visit

RegalBeloit.com



"In the German marine industry, we are well represented with Rotor nl[®] electro motors and Jaure[®] couplings"

LUBRICATION OF ROLLING BEARINGS ON A PAINT SHOP VENTILATION FAN

AUTOMATIC LUBRICATION SYSTEM FROM SCHAEFFLER PREVENTS UNPLANNED DOWNTIME OF LARGE VENTILATION FAN AT BMW REGENSBURG

A downtime of several hours of the painting facility's large fan was no longer acceptable for BMW. The objective was to improve the machine's availability by means of an optimised lubricant supply and reduce the maintenance outlay at the same time.

By installing the FAG CONCEPT8 multi-point automatic lubrication system from Schaeffler on a large ventilation fan at its paint facility, BMW Regensburg is preventing unplanned fan downtime due to inadequate lubrication, which would otherwise cause costly stoppages to production. The BMW Group is one of the world's leading manufacturers of premium-class passenger cars. Since being put into operation in 1986, the BMW plant in Regensburg, Germany, more than 6 million cars have rolled off its production line.

A downtime challenge

In the paint facility at BMW Regensburg, large belt-driven radial ventilation fans are installed to remove waste air

from the paint process. The current high demand for BMW vehicles means that the paint shop works around the clock in a three-shift operation. Every production stoppage reduces the number of vehicle paint jobs that the facility can complete, which in turn interrupts the outgoing supply of vehicles.

Several hours' downtime of the drive-side rolling bearings on one of these fans was deemed as unacceptable to BMW. This downtime had been caused by over-lubrication of the bearings. Due to a large volume of lubricant being added manually on one occasion, the temperature following re-lubrication increased sharply from 55°C to 80°C. This led to a disproportionately high level of stress on the lubricant that

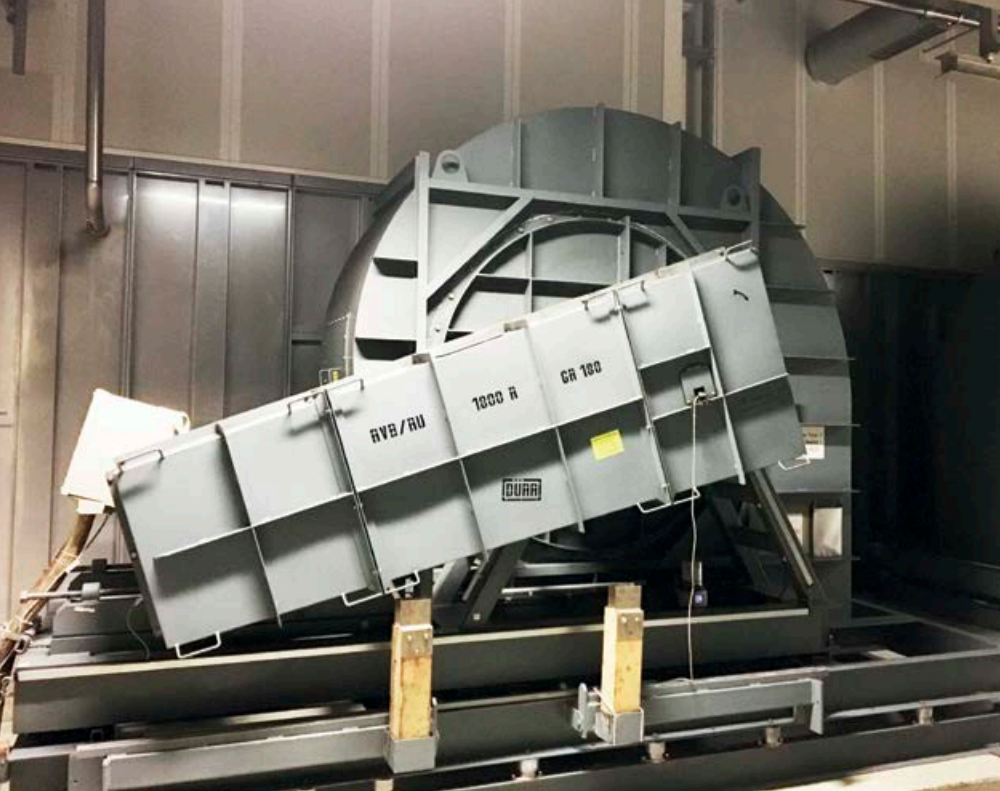


was used, which in turn resulted in premature failure of the bearing.

Following this, BMW's objective was to improve the fan's availability by optimising the supply of lubricant to the fan bearings. In addition, there was a requirement for re-lubrication of the bearings without having to shut down the fan, which would disrupt production.

Solution: multi-point automatic relubrication

Schaeffler and sales partner Altmann recommended that BMW install a



to two plummer block housed bearings on the fan shaft, two rolling bearings on the drive motor, as well as to a seal on the fan wheel housing.

All of the fan's lubricating points are now continuously supplied with the precise volume of lubricant using a single lubricator, which prevents any over-lubrication of bearings leading to unwanted temperature increases, which helps to prolong the life of the grease. Due to this improved supply of lubricant to the fan's bearings, BMW Regensburg is now able to avoid unplanned fan downtime due to inadequate lubrication and therefore any unwanted production stoppages. At the same time, servicing and maintenance have been reduced, as the fan can continue to operate even while lubrication is being carried out, which saves the Regensburg plant around five to six hours of maintenance each month.

Further methods of optimising the use of lubricants at the BMW Group are continuously being developed as part of a long term on-site support service provided by Schaeffler's sales partner Altmann.

Schaeffler Global Technology Solutions

Customer projects that demonstrate definitive cost savings are known as Global Technology Solutions. These case studies show how Schaeffler customers have benefited from its global expertise as well as the local knowledge provided by Schaeffler Technology Centers within the Global Technology Network. For more Global Technology Solutions please visit:

www.global-technology-network.com

FAG CONCEPT8 automatic lubricator on the fan housing. This multi-point lubricator could be adjusted to provide four different lubrication volumes to cater for rolling bearings with varying lubrication requirements. FAG CONCEPT8 ensures a constant, optimum supply of grease to rolling bearings without the need for manual intervention, particularly if machines are located in difficult-to-access areas or are deemed as critical to the production process.

FAG CONCEPT8 provides up to eight separate lubrication points for dispensing precisely metered quantities of lubricant to rolling bearings. The system can dispense lubricant to rolling bearings in a range of industrial equipment, including pumps, fans, compressors, gearboxes, electric motors, machine tools and wind turbines.

FAG CONCEPT8 is fitted with four pairs of lubrication points (eight in total), which are controlled by four individual dispensing pumps. This means that users are able to individually control each pump in order to optimise cycle times and volumes of dispensed lubricant. The system can therefore be adjusted to meet up to four different bearing sizes, each with varying lubrication requirements. Rather than having to purchase multiple single point lubricators to cope with different bearing lubrication requirements, users can buy just one FAG CONCEPT8.

Savings of 5-6 hours' maintenance per month

At BMW Regensburg, one FAG CONCEPT8 system is mounted directly at the base of the fan housing, supplying lubricant



FAG CONCEPT8 installed at the base of the fan housing



Lubricant supply to the fan drive motor.

THE PARALLEL PATHS OF MAINTENANCE AND LUBRICATION

By Tom Murphy, C.Eng. CRL - SDT International

For maintenance programs, the decades-long migration from Breakdown to Planned to Predictive strategies represents significant, albeit slow-paced, progress. It is interesting to note, however, that by comparison, this progress did not filter down equally to lubrication programs. A look at the first two strategy phases - Breakdown and Planned - shows a close analogy between corresponding maintenance and lube processes.

This graphic illustrates how maintenance processes continued to evolve from Planned to Predictive,

Most lube programs evolved beyond the reactive breakdown strategy phase, to employ a planned approach. Lubricating bearings on a prescribed schedule, dictated by time in service made more sense than waiting for failure to happen. A transition from Planned to Predictive rarely happens.

Technology – a catalyst for change

Technology breakthroughs often serve as a catalyst for change. This change is happening now in lubrication. The shift from Breakdown (grease that screaming

Advances in ultrasound technology now provide the maintenance world with an enhancement to the Planned strategy and an equivalent to Predictive strategies; namely, on-condition lubrication.

There are three key problems with the existing planned strategy – we don't know:

1. when the bearing needs lubrication
2. how much lubricant is needed
3. that the lubricant we

just injected did the job

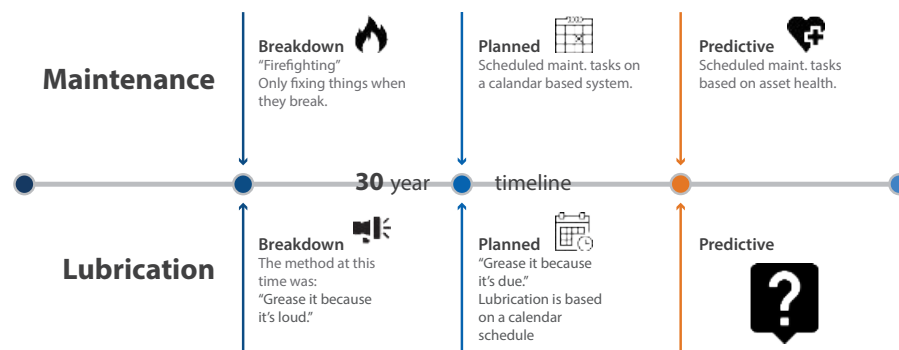
The current lube process is generally based upon a series of assumptions. First, the quantity of grease to inject into a bearing is approximated from its dimensions using this formula:

$$\text{Outer diameter (mm)} \times \text{width (mm)} \times 0.005 \text{ grams}$$

For example, a bearing with outer diameter of 180mm and width of 40mm, has a theoretical grease quantity of 36 grams.

The trickier part is to then derive a relubrication frequency. Once again, a series of approximations and calculations involving the operational conditions of the bearing, its size and rotational speed provide an estimate of this.

The problem is to apply the correction factors to suit every operating condition which a bearing may find itself. Applying the two extremes for a correction factor might produce on the one hand a relubrication interval of 5,333 hours and on the other hand 6 minutes! How can a machine manufacturer provide recommendations that account for every operating condition in the world?





— This graphic illustrates how maintenance processes continued to evolve from planned to predictive, while parallel evolution for lubrication stalled at the planned stage.

while parallel evolution for lubrication stalled at the Planned stage.

Over the better part of forty years, maintenance departments transitioned from a breakdown strategy to planned, task driven, interventions based on time in service. Replacing reactive firefighting with planned tasks reduced waste and extended life. Further evolution to a predictive model delivered even more value. This transition happened for maintenance in general, but did lubrication processes keep pace?

bearing) to Planned Lubrication (grease with a set amount on a set date) to Predictive Lubrication, (lubrication on condition) is real, and driven by innovative ultrasound instruments that help lube techs grease bearings right.

It is generally quoted that over 40% of bearings (some say up to 80%) are killed by inadequate lubrication. Logically this must lead to the conclusion that Breakdown and Planned lubrication processes sometimes fail.

Add a shot of grease Press Enter when completed Or F3 to finish	
0 shots	
71.3	
	

67.8	dBpV before stabilization
Wait ...	9
67.8	dBpVRMS
67.8	dBpVMax RMS

	
Start:	71.8 dB
Finish:	64.0 dB

On-condition lubrication using ultrasound

Alternatively, on-condition lubrication using ultrasound provides data which eliminates these three problems by giving the lube tech

1. A sound to assess
2. Condition Indicators with alarms to measure
3. A dynamic history of the health of every bearing in the program

In a Planned maintenance strategy, ultrasound will tell you when to stop injecting grease. In the Predictive strategy, an ultrasound measurement alerts the lube tech when and if lubrication is needed at all. The grease quantity and interval calculations become only guidelines. Measurement of friction using ultrasound is the

driving and controlling parameter. Ultrasound “hears” friction, so the trained lube tech acquires valuable information on the frictional state of that bearing.

As a rule, “to fail to prepare is to prepare to fail”. So many mistakes occur before the grease gun even reaches the lubrication point. Organizational tasks like lubrication management, storage, and contamination control are essential and their need cannot be over-emphasised. Likewise, the lubrication task itself must also be preceded by preparation.

Preparation Information Essentials:

1. Which lubricant do I use for this bearing?
2. What is the calculated maximum amount?
3. How frequently should we check this bearing?

This task is best managed with software. Combining preparation with friction measurement software provides a smooth, seamless integration between the condition assessment and the lubrication function.

A measurement and lubricant database is created for each bearing. The database controls the sensor type, the lubricant type and the calculated maximum quantity.

How much grease does your grease gun dispense? If the answer is, “I don’t know”, then calibrate your grease guns. Minimise variables that cause errors. Ensure that the majority of grease guns used deliver the same amount.

“Patience is a virtue” applies to lubrication. Build in a waiting time between each injection of grease to ensure that the impact of that injection is detectable. This prevents over-lubrication and allows you to spot failures such as blocked and broken grease tubes.

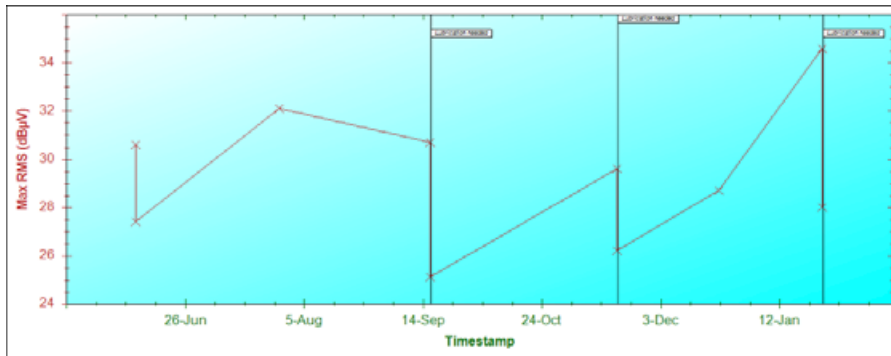
A database Tree and Lube Surveys, similar to ones used for condition assessment, is now created. These surveys, loaded into your ultrasound data collector, guide you to a precise lubrication.

In Survey Mode, the ultrasonic instrument guides the lube tech from point to point and measurement data is the reference to lubricate the bearing. With the reference stored, the detector prompts the technician to begin adding grease. After the waiting time, another measurement dictates the next action.

Planned vs. predictive approach

To assist the lube tech, the ultrasound meter’s built-in algorithms compare each successive reading and suggests





the technician either add more grease at a controlled rate, or decide to stop.

The integration of ultrasound-assisted lubrication can be deployed in either a Planned or Predictive strategy. In a Planned strategy, ultrasound guides the lube process, however the calendar still dictates the intervals between lube tasks. This time-based approach does not take full advantage of ultrasonic conditional data to trigger the lube process. Progressive lubrication programs want to get to that stage.

A successful migration from Planned to Predictive lube tasks is earmarked by message changes. “Inspect Bearings and Grease as Necessary” is replaced with “Take Ultrasound Readings and Grease ULTRASONICALLY Based on Need.”

The result becomes a history for each bearing with the latest bearing condition data always available to listen to or analyse for the presence of early-stage bearing defects. It is important to show that this new lubrication strategy is working. That means developing some performance indicators.

The data collector records the number of shots of grease applied during the lube process and the database knows how much grease is in a shot. Calculating grease consumption therefore, becomes a simple task for this software; and the corresponding consumption reports are meaningful and useful. Showing a reduction in grease consumption along with a measurable improvement in machine reliability is a great way to prove that your program is working. “None of this is particularly new,” you might say. To some this is old news.

But for others, this is science fiction. One great success is documented



from a mine in South Africa.

Prior to implementing a Predictive ultrasound lubrication program, they identified 945 grease points; all lubricated on a time-based schedule. After implementation, the number of bearings needing lubrication quickly reduced. They used to pump all 945 bearings full of grease, every month. This reduced on average to only 19 bearings each week.

At the start of the program, the plant purchased 22 18kg drums of grease each month. Within one month, that dropped to 17 drums and within 6 months, it was below 10 drums. The average amount of grease bought for the subsequent 6 months reduced to 6 drums. Instead of wastefully pumping bearings full of grease, the technicians now devote their time to monitoring bearing condition. Furthermore, while huge savings accrued due to lower grease

consumption, it is recognised that 95% of the bearings are operating at the lowest possible friction levels. This highly effective lube program is delivering longer equipment life and reliability.

There are very few organizations, if any, that benefit from a Breakdown maintenance strategy. Likewise, the concept of the squeaky bearing getting the grease is a dinosaur concept. If a bearing is greased because it is screaming, the damage is done; its lifecycle is already jeopardized. The migration from a Breakdown approach to a Planned

approach represents beneficial evolution for both maintenance and lube processes. The next step forward, from Planned to Predictive, already happened for most maintenance departments. It was a competitive necessity. But lube programs lagged, instead opting for antiquated OEM recommendations that insist lube tasks be triggered by time-based events rather than condition.

The same competitive advantages enjoyed by maintenance, also exist for lubrication programs. As they play catch up, more success stories like our South African mine will appear. These success stories will be driven by innovative technology advancements from progressive ultrasound manufacturers. Indeed, ultrasound-assisted lubrication is the driving force that will realign these two reliability strategies back to their parallel path...

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We produce belts for machine applications in food, agriculture, construction and mining.
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YOUR PERFORMANCE**



“A FOCUS ON EUROPE”

**INTERVIEW WITH
THOMAS AMMERPOHL
SALES MANAGER INDUSTRIAL AFTERMARKET**

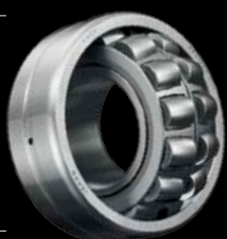


"NACHI has been developing rolling bearings since 1939.

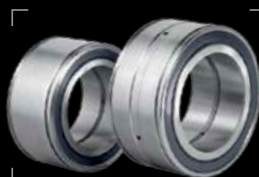
These durable allrounders have solved many problems in a wide variety of applications all over the world."



Deep Groove Ball Bearings



Spherical Roller Bearings



Cylindrical Roller Bearings



NACHI's spherical roller bearings prove their high quality in cranes all over the world.

A conversation with Thomas Ammerpohl, Sales Manager Industrial Aftermarket at NACHI Europe GmbH about the European market, innovations in bearing technology and NACHI's efforts to grow market shares.

Dear Thomas, how are you today and what are your goals for 2017?

Ammerpohl: Well, I'm quite fine. And I'm well prepared for our special efforts to capture larger market shares in Germany and in Europe.

NACHI has a broad range of bearings. But NACHI was not able to play a key role in the European market yet. What are the reasons?

Ammerpohl: NACHI is one of the leading pioneers in technical innovations. We have presented the first spherical roller bearing already in 1939. Today our spherical roller bearings have the highest load rates and are able to run permanently at temperatures up to +200 °C. We can guarantee a very high quality because we carry out and control the entire production process in our own plants, from melting alloy steel to the assembly of the roller bearings. Therefore our products are subject to an efficient quality management. NACHI's bearings meet all the technical requirements. Our present task is to proclaim these advantages to our customers.

How will you find the path to the customer?

Ammerpohl: NACHI always has been and still is a globally acting company. NACHI trades with regional partners. In the next months, we will encourage the regional traders in Europe by means of technical training and assistance. We will increase our investments in marketing and we will be showing significant market presence in the European area.

Our goal is to enable our trade partners to support customers in each and every situation. Our regional trade partners should be able to analyze the inquiries of their customers, to give comprehensive advice and to suggest the best solution for each individual demand. To achieve this NACHI will give trade partners the necessary training and detailed technical information. We are in the process of preparing catalogs, brochures and of course detailed web-based information.

**No.1
IN THE
WORLD**

Spherical roller bearings with the highest load rating in the world.

Are there any specific target markets on which you will be focusing?

Ammerpohl: Well, presently we offer our improved spherical roller bearings series EXQ-V. Their main advantage is the very high resistance against vibration and impact load. We will focus on the branches that can profit from these advantages. For example: construction machinery. Our goal is to get closer to our competitors very soon.

Moreover, we have some other products that are able to meet the specific requirements of special branches. For example, our precision machine tool bearings. NACHI offers a wide range of angular contact ball bearings, combined angular contact roller bearings and cylindrical roller bearings. They are specially designed for use in machine tools, to support high precision pre-tensioned feed spindles and main spindles in machining centers and turning centers. In Asia, NACHI is already the market leader in some of these application areas. We are convinced that we can transfer that success to the European market.

Do you have a special strategy to meet customers in selected industries?

Ammerpohl: Well, as we want to get very close to the requirements of our customers and as we want to understand their technical demands we plan to have a few direct contacts. We want to serve some selected customers as OEM. This will give us the chance to directly look at the specific conditions under which our bearings have to run. This will enable us to develop bearing solutions which are specifically optimized to the customer's demands. Even our standard bearing solutions will profit because the knowledge gained with our OEM-partners will lead to improvements in the whole production range.



Thomas Ammerpohl, Sales Manager Industrial Aftermarket at NACHI Europe GmbH

So far, we have extensive experience in various applications because NACHI is an integrated manufacturer of hydraulic equipment and machine tools in Japan. That gives us the possibility to test our components, for example, our different types of bearings, in our own applications.

What is your approach to winning distribution customers in the saturated European market?

We already have long-term relationships with reputable distributors in Europe. What we will do is: improve our performance in availability and customer service even more. We do need our distribution partners and we consider them – different to many competitors as real partners. To have a mutual approach and individually altered strategy is our main concern.

What are the reasons that you start your marketing offensive just this year?

Ammerpohl: NACHI Europe GmbH celebrates its 50th anniversary in 2017. We are very proud of our technical innovations, of our continued development in the German market and of our good relations with our current customers. For us, this is a great motivation and challenge to perform better and to develop the local German market as well as the European market.

What is more, the German market is very demanding. If you get along with all the requirements concerning the technical performance and the quality in Germany, you will get along anywhere. In a few applications, NACHI's products cover these outstanding demands. It's our challenge to prove that we can comply with a broad range of other applications. Of course, we are striving for success!

Thomas, thank you for your information and I wish you every success in achieving your goals!





BEARINGS · TRANSMISSIONS · LINKAGES

DUNLOP BTL

VII



BEARINGS

Dunlop Premium bearings are manufactured in Europe and in the UK. With more than a sixty-year history it is a proven and reliable manufacturer and supplier of certified premium bearings for a vast range of applications which can include agricultural, automotive, construction, industrial and motor sport sectors.

TRANSMISSIONS

Dunlop offer a unique range of mechanical power transmission products to meet today's stringent and ever increasing customer requirements. Transmission products are manufactured in Europe, the UK and Asia. All are constructed from high quality materials and are finished to tight dimensional tolerances.

LINKAGES

Dunlop linkages and linkage components are proudly manufactured in the UK and are used to transfer mechanical motion. Whether that motion is shifting the cutting height in a lawnmower or controlling the exhaust valve on an articulated lorry, we specialise in the supply of custom made rod-based linkages.

Availability

Many of the world's most prestigious original equipment manufacturers in the agricultural, automotive, construction, industrial and motor sport sectors rely on quality Dunlop products.

A comprehensive network of MRO & replacement distributors throughout Europe and the rest of the World is also available, ensuring our products are readily available quickly and efficiently.

UK and European Manufacturing

DUNLOP BTL is proud to be a committed European manufacturer of Bearings, Transmissions and Linkages.

We believe in the future of European manufacturing and will continue to focus and further enhance the requirements and expectations of our customers globally.

As a proud manufacturer we want to help Europe's industry flourish and to meet the world's evolving appetite for innovative designs and responsibly produced quality manufactured products.

New UK Production Facility

During 2016 UK production moved to a newly refurbished manufacturing facility this enable further expansion and additional production machinery as well as additional production staff.

Being based in the North East of the UK meant the Consett site would become it's main European manufacturing and distribution centre, producing around 50% of its products, while other items are produced in factories from around the world.

In addition to our catalogue ranges of Bearings, Transmission and Linkages we produce non-standard items to suit individual customer requirements, 40% of our total production is for bespoke products to specific customer design our organisation.



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PACKAGES



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Investment is constant, continually expanding and upgrading our portfolio of production facilities and machinery globally. The latest computer controlled inventory of over 30,000 part numbers covering 42 different product groups are held in stock and available for immediate dispatch.

Dunlop BTL Ltd is committed to offering all of our customers, not only the widest range of quality products but also a world class quality service. We have a dedicated quality department striving towards continuous improvements in all aspects of our company.

Our commitment is to quality to continuously improve in every aspect of the company activities, we are UKAS approved company to ISO 9001:2008

Our level of environmental commitment remains ahead of the industry trend. UKAS approved to ISO 14001:2004.

As a quality conscious European manufacturer we take our environmental responsibility very seriously. Quality Confidence – when purchasing any Dunlop product you can be reassured that not only have the materials of the highest quality been used with full production traceability, but also that they have been produced in a responsible way, by a manufacturer who cares about the environment and its staff and has the expectations and demands of its customers foremost.

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Ashford, Kent, TN23 1EL. *United Kingdom*

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PICARD PREMIUM BEARINGS AND LINEAR MOTION TECHNOLOGY **EXCLUSIVELY FOR THE SPECIALISED TRADE**



A league of nations and cultures

A total of 142 employees from 29 different countries work at the company headquarters of this long-established company founded in 1922 in Bochum on the Ruhr, Germany. And the company is more than proud of this diversity of nations and cultures. As Managing Director Hans-Martin Reinhardt says: "We are very different particularly because of our employees. They talk to our customers in 19 languages. When I go to the staff canteen at lunchtime, I feel as if I am part of a large, international family. In spite of our technical products, our employees make everything human and personal – and like to take the time to talk to their

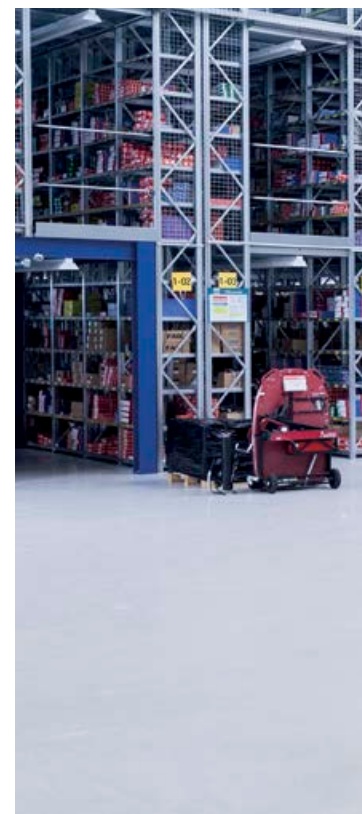
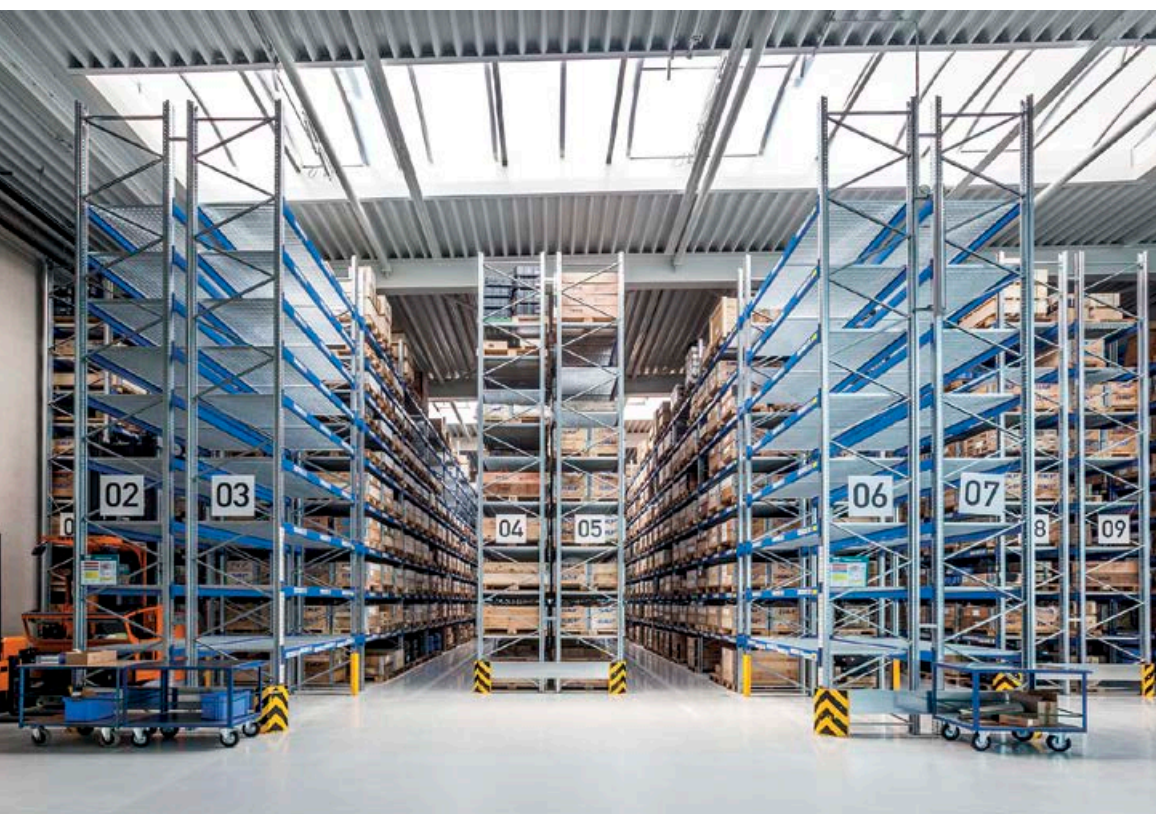
customers about things such as football, films and recipes." It goes without saying that PICARD is engaged in the training of young people, offering training schemes in three different professions every year.

What also makes the bearings and linear motion technology experts so interesting for the customers, all of them specialist technical dealers all over the world, is an ingenious logistics concept and an unconditional desire to produce the very best quality. And that starts with product selection. At PICARD customers primarily have a choice of premium brands. There are an incredible 33,200 articles worth more than 32.5 million euros in stock. This means that PICARD can supply a lot of

types which are not currently available at the manufacturer's and are thus subject to delayed delivery.

Strong supply chain

Furthermore the company distinguishes itself with its sales strategy. The customers receive their products from all manufacturers. This is where they benefit in particular from the strong supply chain: PICARD delivers the required number of the right bearings at the right price not just within Europe, but also all over the world. And when every second counts for the customer, PICARD guarantees to hand over the goods to a taxi 30 minutes at the latest after the order has been placed as





"PICARD delivers the required number of the right bearings at the right price not just within Europe, but also all over the world."

part of its courier express service – at fixed prices up to a radius of 300 km from the Bochum site.

Maximum availability, comprehensive selection, best prices and due-day-oriented logistics options are at the top of the list of demands that PICARD makes of its own quality standards. This is demonstrated perfectly at all times in the PICARD online shop. A countdown for customer delivery takes place there every day and is right to the second. In other words: placing orders from Monday

to Thursday by 7 p.m. CET (Friday by 5 p.m. CET) ensures that the goods will be dispatched the same day. And there are virtually no picking errors or packages sent to the wrong address because every consignment is checked twice in terms of correctness and completeness.

But that is not all when it comes to logistics. For its customers, PICARD also creates all the necessary customs documents for dispatch outside the European customs union free of charge.

Customers can place their orders round the clock in the PICARD online shop and simply configure their individual linear rails. They can find out about when the consignment is going to be dispatched by e-mail and use the track function to check the current status of the delivery quickly. In addition the website provides comprehensive technical information on bearings, accessories and linear technology for download.

The bearings are packed in specially designed cardboard packaging to ensure the goods arrive at the customer's in perfect condition. Special environmentally-friendly filling material ensures the goods are perfectly protected during transport on their way from Bochum to the rest of the world.



TSUBAKI NAKASHIMA Co., LTD ACQUIRES PRECISION BEARING COMPONENTS GROUP OF NN, INC.



Leading Bearing Component Manufacturers Merge to Form Powerful Combination



rollers, cylindrical rollers, spherical rollers, stamped and welded bearing cages, sheet metal parts, injection molded components, ball screw, linear motion systems and air blowers.

The combination of these two companies additionally provides:

- Further growth opportunities in new markets and new applications
- A complimentary strategic combination to benefit all stakeholders
- Additional production and R&D capabilities
- An enhanced global footprint to serve the growing ball market

Together, Tsubaki Nakashima and PBC share many synergies, including a common culture of continuous improvement as well as an emphasis on quality, safety and delivering superb value to its stakeholders. The new combined company will begin integrating its operations over the next several quarters.

www.tsubaki-nakashima.com

On August 17, 2017, Tsubaki Nakashima Co., Ltd. announced that it had successfully completed the acquisition of the Precision Bearing Components (PBC) Group of NN, Inc. The acquisition of PBC represents a strategic fit for both organizations and brings together two companies with a complementary and broad product portfolio to serve global markets.

As a well-respected steel ball and precision products manufacturer, Tsubaki Nakashima has an established track record of global growth. The company's established footprint in Japan, China and Asia, together with the strengths of PBC in Europe and North America, results in a total of nineteen manufacturing facilities worldwide.

Precision steel balls have long been a staple product for both companies.

In addition, Tsubaki Nakashima also produces balls in a variety of materials to serve growing markets. Complementary to the business of rolling elements are the precision rollers produced by PBC. As the demand for precision rollers continues to grow, the newly combined company has a positive outlook on growth opportunities with its now larger-than-ever production capabilities.

An expanded product portfolio will encompass the production of balls from steel, tungsten carbide, ceramics, glass, and plastic; as well as producing tapered

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49 years ago, a dream led to what is today a Movement; a movement called KG International that is going strong based on the beliefs, principals and ethics of the founding Chairman Mr. Kedar Gupta who founded the business in India way back in 1968

The tiny acorn that germinated from an idea, a potential foreseen, is today a mighty oak in the shape of KG International of Jebel Ali Free Zone, Dubai. Sprawling over 55 countries in 5 continents, with a team size of over 100; KGI believes in forging relationships that last.

It has taken passion, determination, steely resolve and belief to create this reality, to make KGI a company favoured the world over for its quality, reliability, customer centricity and range on offer.

To further strengthen our Movement, aiming to become an engineering solution partner to the MRO / OEM segment and keeping customer needs in mind, KGI extends bearings business to include power transmission products:

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- Oil Seals from Taiwan
- Linear Motion Guides & Ball Screws from Hiwin of Taiwan
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SMART MOUNTING AND DISMOUNTING OF BEARINGS AND OTHER MACHINE PARTS

NEW GENERATION OF MEDIUM FREQUENCY INDUCTION HEATERS

Bega Special Tools introduced a new generation of induction heaters at this year's Hannover Messe. The Betex MF Quick-Heater 3.0 is a medium frequency induction heater for mounting and dismantling bearings and other machine parts made from steel, stainless steel or titanium. These new heaters enable users to perform safe, fast and clean operations. Equipped with smart processor technology, the new heating system allows a far better control of the heating process and data storage for future reference.

Utilised for the installation and dismantling of bearings and other metal machine parts such as labyrinth seals, bearing rings, bearing inner rings, sleeves, bushes, couplings and gears, medium frequency induction heating offers a cost effective heating method. The optional flexible inductors can be wrapped around any size or shape, not limiting their use to components with a cylindrical shape. Thanks to the Betex MF Quick-Heater's compact and mobile design, it can easily be moved around in the workshop or factory saving time. It can be deployed very rapidly, heating faster than conventional methods. Thanks to its more efficient electricity consumption, energy use is much lower. It has a low connection power of 32 A or 63 A. The generators are adjustable from 2.5 kW to 22 kW or 44 kW. The clean system operates very quietly, without any residual magnetism, fire hazard, excessive noise or polluting fumes. Improving the quality of installation or maintenance, the MF Quick-Heater 3.0 is suitable for production as well as maintenance applications in MRO and OEM companies.

The new generation medium frequency Betex MF Quick-Heater 3.0 features



Two BETEX Middle Frequency Quick-Heaters are simultaneously heating a large bearing for a Wind Turbine manufacturer

smart processor technology. Of compact design, it has a large touch screen, a USB port for software upgrade, and a log-in option for remote servicing. The unit heats according to a preset temperature/time curve and displays the temperature development in a chart, whereas the heating cycle can be saved on a PC or a USB flash drive. Smart electronics ensure the optimal operating frequency and provide the user with tips on optimal heating, for example by suggesting the deployment of more or fewer windings. These heaters come with adjustable power control as well as dual temperature sensing (monitoring ΔT). Moreover, they have the option enabling the user to operate several heaters in combination.

"The new heating system allows a far better control of the heating

process", explains Henk van Essen, Bega's Managing Director. "Bearing manufacturers are producing expensive bearings while recommending to their customers the correct mounting and dismantling procedures. Especially in certain industry sectors such as railways and wind power, there are strict safety regulations that have to be observed. For quality and safety reasons, users are required to consistently log all maintenance activities performed on components. Thanks to the applied smart technology of the new Betex MF Quick-Heater 3.0, heating and mounting data and protocols can be saved for future reference. Given this feature, users may now say: The bearing's installation was performed according to the specifications and we are able to prove it."



The new generation of compact middle frequency Betex MF Quick-Heaters 3.0, deployed for mounting and dismantling of metal components in all types of industrial sectors.

You can find more information on

www.bega.nl



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WHAT TO EXPECT FROM CHINA'S BEARING STEEL INDUSTRY

by DAVID HULL – August 2017

Earlier this year, David Hull, the founder and president of Precision Components Inc., gave an in-depth analysis of projected Chinese bearing steel production in 2017. Backed with his company's latest research, including leading industry news, Mr. Hull discusses continuing market trends and what to expect in the coming months.

Remain seated with your seatbelt fastened; this ride has not come to a complete stop. Riding the economic roller coaster of any industry can be as unpredictable as it is frightening, particularly when the largest players in the game are running out of capacity. As far as Chinese bearing steel production goes, we made it past the first hill, but this ride is far from over.

Worldwide bearing steel production at the beginning of 2017 was flush with capacity, however, many companies purchasing Chinese bearing steel felt the sting of higher prices as well as delays in production. At the time, the economy was rapidly picking up and OEM demand for finished bearings was projected to majorly

increase. Steel suppliers reacted accordingly at the expense of the consumer, leaving many companies struggling for steel. For anyone purchasing Chinese bearing steel in 2017 we expected the availability, price, and service scales to lean further away before they balanced out. So what have we seen since then, and what can we expect moving forward? The bearing steel pricing roller coaster in China, as expected, peaked in February, bottomed in April, and continues to trend upward. Although current pricing is lower than it was in the first quarter, it is approximately 72% higher than 2016 first quarter pricing, which was at a 12-year low. This is in part to a lower economic forecast in China as well as a slight change in OEM demand for finished



Dave Hull is the founder and president of PRECISION COMPONENTS, INC., which for the last 27 years has provided engineered metal products and services to major manufacturers. For information on Mr. Hull, you can read his BIO on www.pcomponents.com. Facts and Figures are based on research performed by Precision Components Asia.

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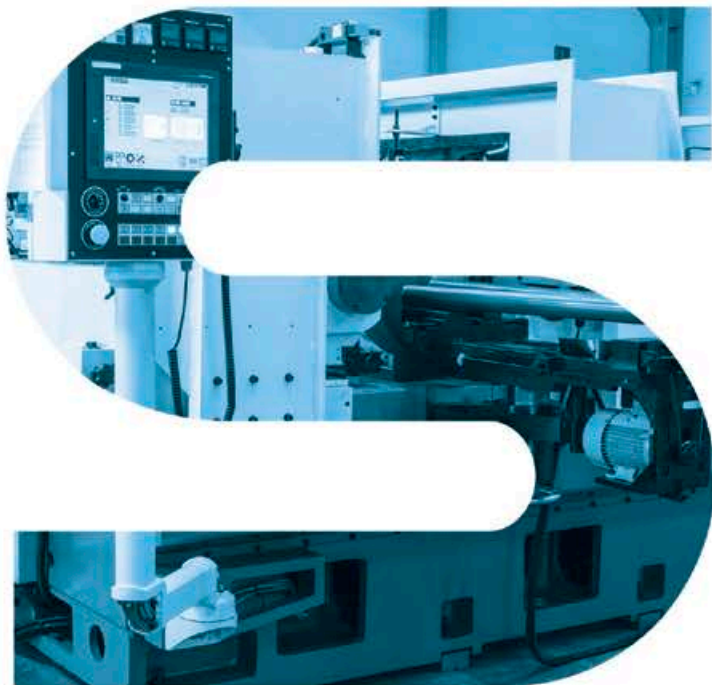
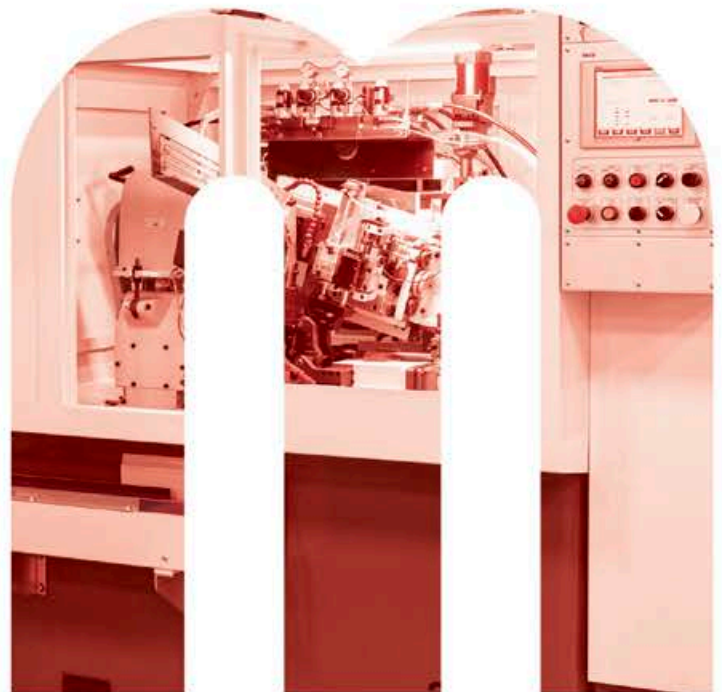
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bearings.

Despite seeing a June increase, the expected increase in demand for bearings has softened. Increased demand for equipment manufacturing is now expected to increase at a rate of 0.7%, with automotive applications expected to increase by 1.1%, and electrical machinery by 1.6%.

Although the economic forecast increase for China has been lowered, the government has also reduced steel making capacity in 2017 by 50,000,000 metric tons. This is part of an economic restructuring policy with the aim of de-stocking and reducing overcapacity. The net result is continued higher pricing and potential lead-time issues. The capacity reduction is across all steels and mainly affects smaller, lower quality, and altogether unprofitable mills. The customers of those mills will still need to buy their steel, increasing the demand and pressuring the capacity of higher-grade mills. It's important to understand that the production rate of Chinese bearing steel producing companies ranges greatly, from as high as + 42% to as low as -17%.

Additionally, China's mindset of mass production plays a prominent role in production scheduling. Major Chinese producers of bearing grade steel prioritize high volume orders for high volume melts. All other small orders using less material become less important if they are filled at all. A prime example of an industrydominating company is the CITIC group (Xingcheng and Daye). They are the largest producer of bearing grade steel in China

controlling 42% of the market and are roughly 4 times the size of the number 2 producer. As you can imagine, small, specialized orders will pose more of a headache for companies of this size. And now restructuring is causing even more pressure to absorb this business from smaller unprofitable mills.

To further the demand, China has also been promoting domestic production to encourage Chinese branded bearings, which in turn leads to higher demand for bearing steel production. Last year we saw an almost 15% decrease in bearing steel exports while overall Chinese production was at an increase.

To conclude, 2017 remains challenging for anyone purchasing Chinese bearing steel. In particular anyone needing special sizes and products manufactured to non-Chinese specifications such as SUJ2 and 100Cr6, along with anyone buying products that are slightly different than China national standard specifications. Overall, the Chinese economy remains at a steady increase, however, it is not moving as quickly as expected. Economic forecasts are lower and expectations of material shortages are not as severe. With demand building at a slower rate, mills in turn have more time to react allowing the supply chain rubber band to stretch without breaking. That being said, there is a more positive outlook, however, we are not out of the woods. OEM demands for finished bearings continue to increase.

PCI info update: Changes made to Chinese bearing Steel Standards (Carburized Material)
Carburizing steels for bearings worldwide are most commonly found in larger bearings where shock or impact loading can be an issue. For example metal mill applications.

China's "carburizing steels for bearings," have been updated to GBT 3203-2016. This replaces GBT 3203-1982. Implementation of this updated standard will take effect September 1, 2017 and has some notable additions to the standard. Several new bearing chemistries have been added so the standard now covers 7 materials.

In addition some of the element ranges to the previous chemistries have been added to tighten the chemistries in the 2016 version. These changes bring the new standards in line with US and Japanese standards for carburizing steels for bearings. China now recognizes an equivalent to SAE4118H (G 20CrMo), 8620H (G 20CrNiMo) and 3311 (G 20CrNi4). There are also some of the more specialized chemistries used for high-speed rail applications, and higher silica formulas for metal mill applications. It is important to remember that the global bearing manufacturers have their own specifications for bearings steels, which in most cases are more stringent than the ISO, JIS, or GBT standards.

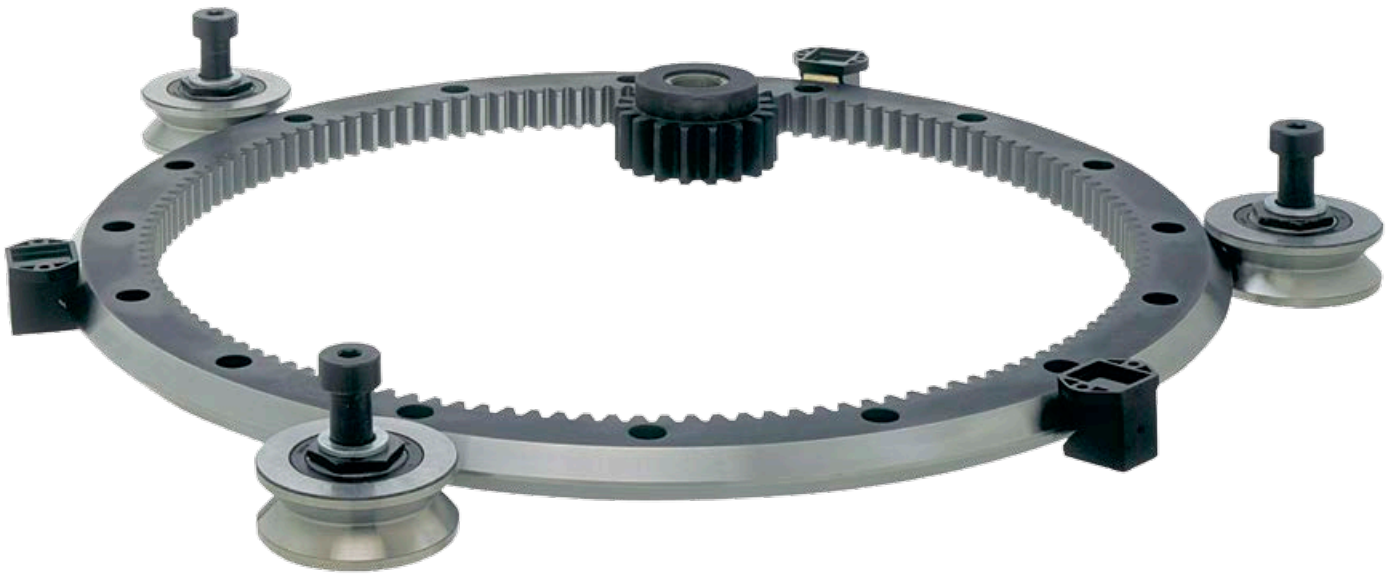




CASE STUDY

HDRT GUIDANCE SYSTEM OPTIMISES MANUFACTURE OF HIGH-PRESSURE STEEL CYLINDERS

HepcoMotion's HDRT (Heavy Duty Ring Guides and Track Systems) have been developed specifically for high-performance applications. HDRT guidance systems are characterized by their ability to carry very high loads – moving reliably and accurately with very little wear. At Eurocylinder Systems AG, a leading manufacturer of high-pressure steel cylinders, the HDRT guidance system has proven itself in a demanding production environment with large amounts of contamination and residues.



Eurocylinder Systems AG is a medium-size company in the metal processing industry. Eurocylinder produce high-pressure steel cylinders for the storage and transportation of compressed, liquefied and dissolved pressure gas used in technical, fire protection, diving, beverages and medical applications.

The production of high-pressure steel cylinders

The high-pressure steel cylinders are made from steel tubes. The steel tubes are cut into casings of the required length, between eight to twelve metres. The wall thickness varies from three to nine millimetres, with six different diameters – 140, 172, 178, 204, 229 and 267mm. At the plant, around 1000 casings are cut per day. Every year, Eurocylinder Systems produces approximately 500,000 high-pressure steel cylinders. The plant is predominantly operated in rolling shifts or in three-shift operation and is in operation for over 300 working days per year.

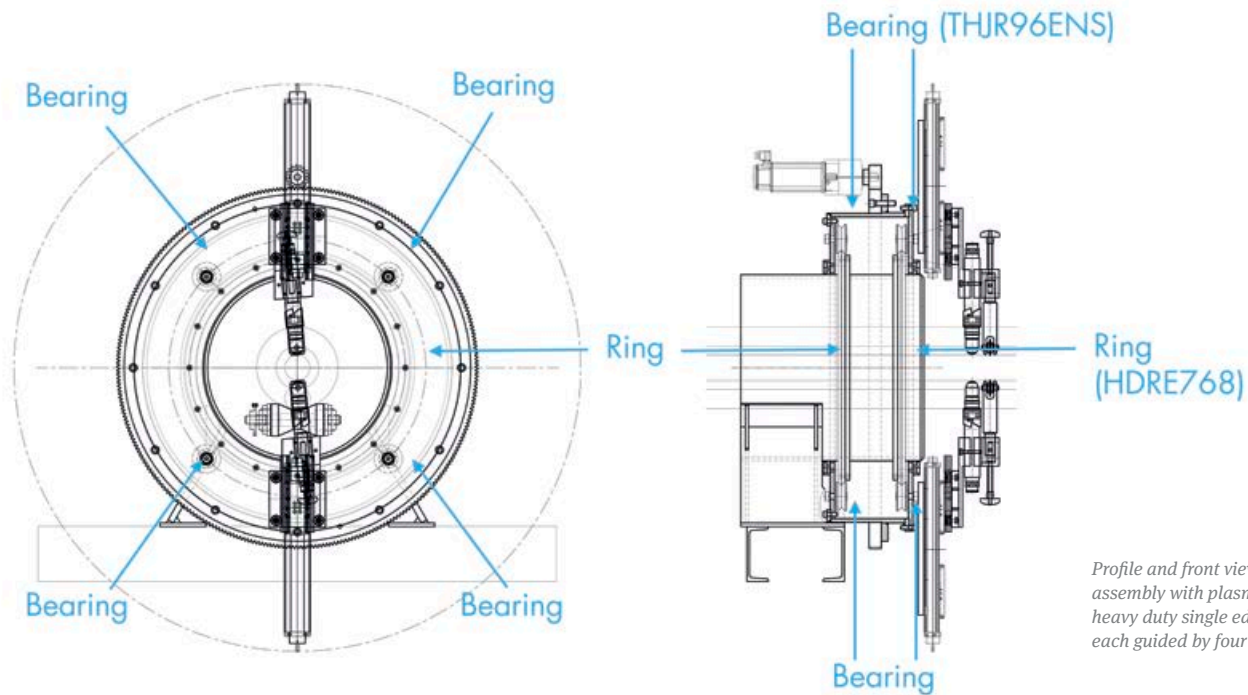
Before-after comparison

Historically, the cutting of the casings was done using two bandsaws. For this, the supplied tubes were cut into casings of the required lengths with vertical cuts (perpendicular to the tube axis). This was a lengthy process that took up to five minutes per cut. Eurocylinder Systems wanted to optimise this complicated and long process. In 2009 the bandsaws were replaced by a plasma cutting machine. The cutting head of the plasma system has two plasma torches. They are placed opposite each other and rotate during the cutting process on a circular path 180° around the steel tube. One cutting head is responsible for the upper half of the pipe, the other for the lower half of the pipe.

A complete pipe cut takes between five and ten seconds, depending on the tube diameter and thickness. The holding and guiding of the whole cutting head is done by two HepcoMotion HDRT guide systems.

Requirements: no wear and low maintenance

To guide the plasma cutting heads along a prescribed circular path, a ring-shaped high-performance guide system was required that can meet the required operating times free of faults. The main requirement was to install a guide system that can be wear-free and low-maintenance in operation. In addition, the rings need a high load-bearing capacity to support the entire



Profile and front views of HDRT ring assembly with plasma burners. Two heavy duty single edge rings are each guided by four V bearings.

cutting head (approximately 150 kg in total) and operate at the required rates. The plant is in a hall subject to ambient temperatures. The guide must therefore be resistant to contamination arising from the production process and withstand the external influences – in particular, the temperature variations. This means that the plant and the guides must be operable with minimal downtime during any weather, in any season, with temperatures between 25°C and +40°C.

Challenges: Deposits and impurities

Due to the technical conditions of the plasma cutting process, large amounts of combustion residues and contamination are produced during this production step. During the cutting process, the burnt material is carried into the interior of the pipe casing by the plasma jet, which causes problems later on in the processing. The casings must therefore be cleaned following the plasma cutting.

Rails and guide systems also become polluted with slag splashes and fine dust deposits from the plasma fumes. For this reason, Eurocylinder Systems installed a special housing with a felt ring seal for the HDRT rings that protects the HDRT rings from external influences such as dirt and dust.

Solution withstands extreme production environments

To withstand the demanding environment, HepcoMotion configured a solution consisting of two heavy-duty rings. These rings feature Hepco's V guide technology that delivers a self-cleaning action, which means that any contamination is wiped away by the V bearings as they run along the rail. HepcoMotion has been leading the development of V Guide technology since 1969, and continues to develop innovative linear products that offer new solutions to design engineers.

In this application, each ring has a diameter of 786 mm and is made from hardened high-quality tool steel. The HDRT running surfaces are precision-ground. The two parallel rings each use four 95mm diameter eccentric V bearings for the high loads. Lubrication is provided by four lubrication blocks (two per HDRT ring). The blocks are made of impact-resistant plastic including a spring-tensioned, lubricant-soaked felt wiper for low-friction lubrication as well as high load capacity and lifetime. The lubrication blocks have now been in service for seven years without being refilled.



During the plasma cutting, there are considerable amounts of deposits and dirt - particularly slag and soot-like fine dust. Both the plant and the HDRT solution from HepcoMotion are exposed to this, but have now been in place for seven years without any maintenance or failure.



The plasma cutting heads are guided by the HDRT rings. One cutting head deals with the upper half of the tube; the other with the lower half of the tube.

Plasma Cutting Heads



HDRT rings and plasma cutters give a time saving of at least 60%

The main aim of Eurocylinder Systems was a major optimisation of their plasma cutting process while at the same time accelerating and automating the cutting process. Eurocylinder Systems is very impressed with the new solution – in particular with the HDRT rings for fully meeting the requirements. Using the bandsaw, up to four pipes were cut simultaneously, depending on the diameter. The bandsaw required five minutes, just for the cutting. With an overall cycle time of about six minutes, that means 90 seconds per casing. The plasma cutting system only needs ten seconds for one cut. The total cycle time amounts to about 30 seconds per casing. The time saving is therefore about 60 to 70%, if the tube length, diameter and wall thickness are the same.

HDRT ring with self-cleaning V guide

The system has been in use since 2009, and the HDRT rings at the cutting head of the plasma cutting system have not required any maintenance. The entire system and the HDRT rings have now been running for over seven years, without any errors or faults, demonstrating how strong and resistant the HDRT guidance system is. The HDRT rings are highly tolerant of dirt thanks to the geometry between the V guide and the V bearings which has a 'mill stone effect' caused by the different peripheral speed inside and outside the V form. The difference in speed causes particles of dirt nearer the centre to move outwards towards the periphery, and to be expelled.

With global recognition for innovation, HepcoMotion focuses on manufacturing linear solutions that deliver quality and precision. With branches and distributors in 41 countries, we provide extensive application support through a global network of qualified, experienced and factory trained engineers backed up by a substantial and experienced manufacturing capability.

For press enquiries and additional images please contact Tanya Frost on 01884 243400 or email tanya.frost@hepcotion.com



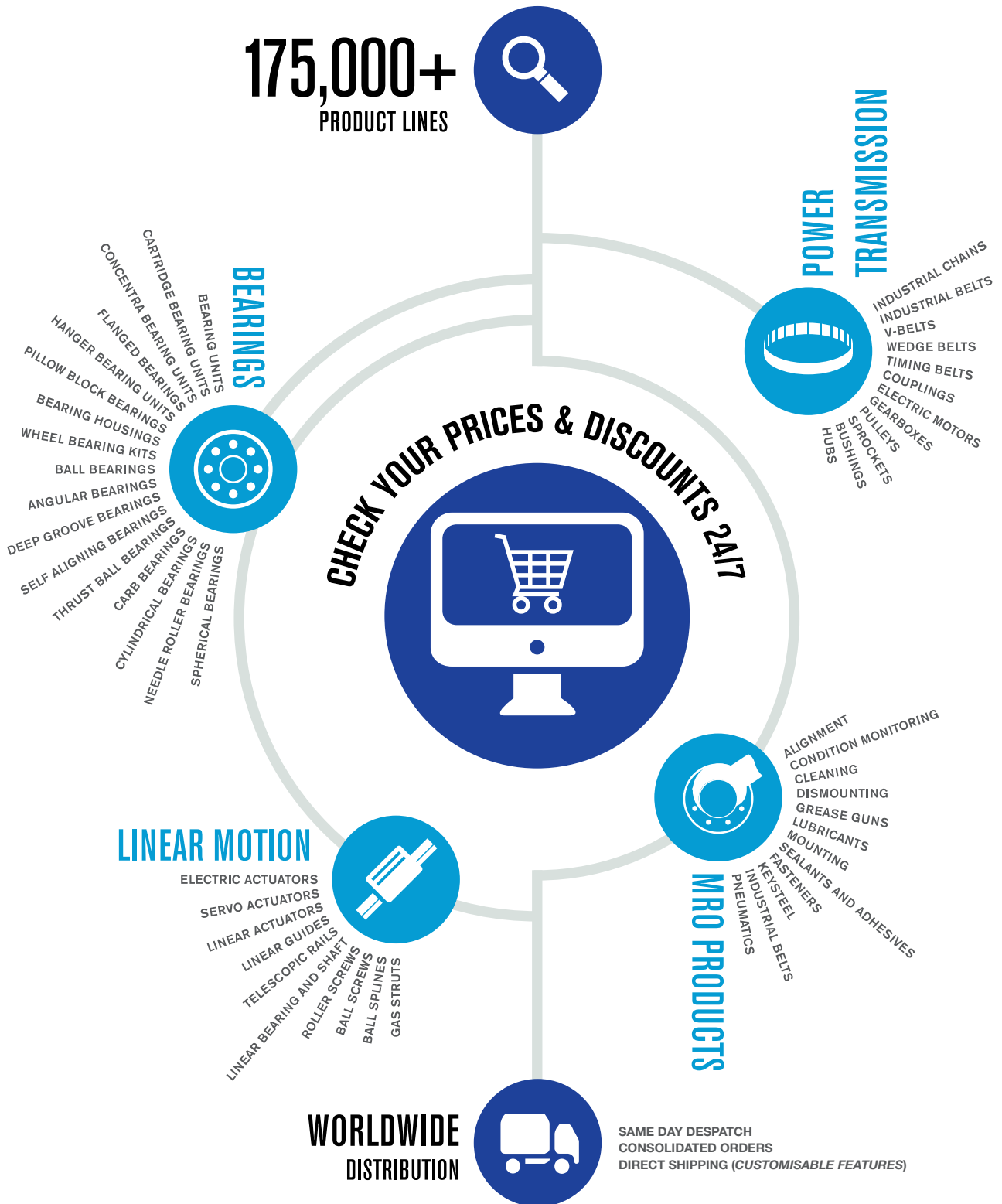
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PREPARATION AND APPROACH TO BEARING DAMAGE ANALYSIS

BEARING DAMAGE: OVERVIEW OF THE FACTS

Timken analyzes bearings from operations across the world. Our bearing service and repair specialists find that fully 50 percent of the bearings submitted to us haven't reached their calculated lives. In some cases, the cause is contact fatigue (inclusion origin, point surface origin, geometric stress concentration and micro-spalling). In 90 percent of the cases, though, the cause is non-fatigue factors, including:

- Foreign materials.
- Corrosion.
- Inadequate lubrication.
- Improper handling.
- Bad running conditions.

If you're concerned that your bearing is deteriorating, look for the following signs:

- Vibrations – whether felt by hand or measured with a frequency analyzer.
- Abnormal noises.
- Displacement of rotational centerline.
- Running temperature increase.
- Odd smells.
- Lubricant deterioration.
- Lubricant leakage.
- Visual discovery during routine maintenance check.

SUGGESTED PROCEDURE FOR BEARING ANALYSIS

Follow the steps below for an accurate and complete analysis when investigating any bearing damage or system breakdowns. If you need help, contact one of our sales or service engineers.

1. Gather operating data from bearing monitoring devices; analyze service and maintenance records and charts; and secure application diagrams, graphics or engineering drawings.
2. Prepare an inspection sheet to capture all your observations. Take photographs throughout the procedure to help document or describe the damaged components.
3. Extract any used lubricant samples from bearings, housing and seal areas to determine lubricant conditions. Package it separately and label it properly.
4. Secure a sample of new, unused lubricant. Record any specification or batch information from the container. Obtain the technical specifications and any related material safety data (handling, disposal, toxicological) documentation to accompany lubricant shipments.
5. Check the bearing environment for external influences, like other equipment problems, that preceded or occurred at the same time bearing damage was reported.
6. Disassemble the equipment (either partially or completely). Record an assessment of the mounted bearing condition.
7. Inspect other machine elements, especially the position and condition of components adjacent to the bearing, including locknuts, adapters, seals and seal wear rings.
8. Mark and record the mounted position of the bearings and components prior to removal.
9. Measure and verify shaft and housing size, roundness and taper using certified gauges.
10. Following removal, but before cleaning, record observations of lubricant distribution and condition.
11. Clean parts and record the manufacturers' information from markings on the bearing rings (part number, serial number, date code).
12. Analyze the condition of the internal rolling contact surfaces, load zones and the corresponding external surfaces.
13. Apply preservative oil and repackage the bearings to avoid corrosion.
14. Compile a summary report of all data for discussion with Timken sales or service engineers.

WEAR –

ABRASIVE CONTAMINATION

Foreign particles cause wear and damage. Foreign particle contamination can cause abrasive wear, bruising or circumferential lining (grooving).

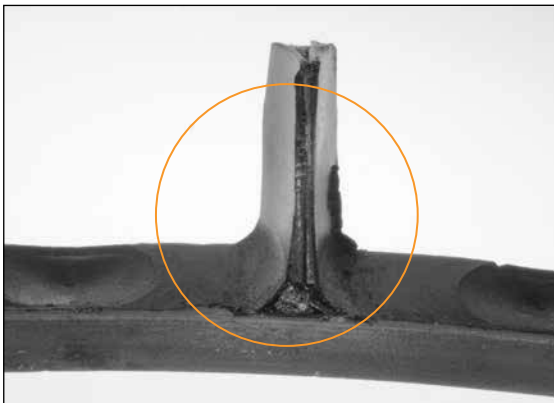


Fig. 1. Fine particle contamination entered this spherical roller bearing and generated wear between the cage surfaces, rollers and races



Fig. 3. Fine particle contamination caused abrasive wear on this tapered roller bearing

ABRASIVE WEAR

Fine foreign material in the bearing can cause excessive abrasive wear. Sand, fine metal from grinding or machining, and fine metal or carbides from gears wear or lap the rolling elements and races. In tapered bearings, the roller ends and cone rib wear to a greater degree than the races. This wear causes increased endplay or internal clearance, which can reduce fatigue life and create misalignment in the bearing. Abrasive wear also can affect other parts of the machine in which the bearings are used. The foreign particles may get in through badly worn or defective seals. Improper initial cleaning of housings and parts, ineffective filtration or improper filter maintenance can allow abrasive particles to accumulate.



Fig. 2. The roller end wear on this spherical bearing also was caused by fine particle contamination

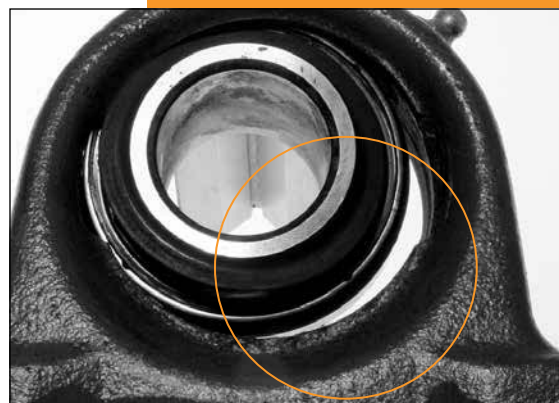


Fig. 4. Exposure to abrasives and water in a severe environment caused extreme wear on this pillow block bearing

WEAR – PITTING AND BRUISING

Hard particles rolling through the bearing may cause pitting and bruising of the rolling elements and races. Metal chips or large particles of dirt remaining in improperly cleaned housings can initiate early fatigue damage.

Common external debris contaminants include dirt, sand and environmental particles. Typical causes of internal debris contamination include wear

from gears, splines, seals, clutches, brakes, joints, improperly cleaned housings, and damaged or spalled components. These hard particles travel within the lubrication, through the bearing and eventually bruise (dent) the surfaces. Raised metal around the dents acts as surface-stress risers to cause premature spalling and reduce bearing life.

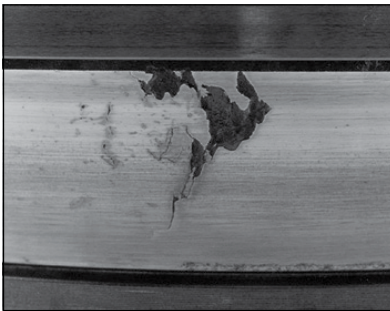


Fig. 5. A tapered roller bearing inner race (cone) with spalling from debris contamination bruises

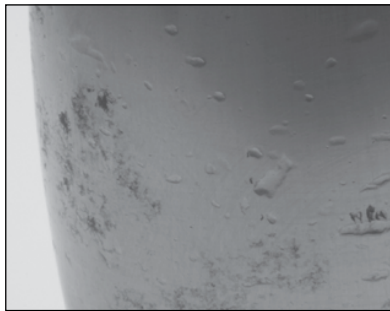


Fig. 6. Hard particles caused contamination bruising on this spherical roller bearing



Fig. 7. Debris from other fatigued parts, inadequate sealing or poor maintenance caused bruising on this tapered roller bearing race

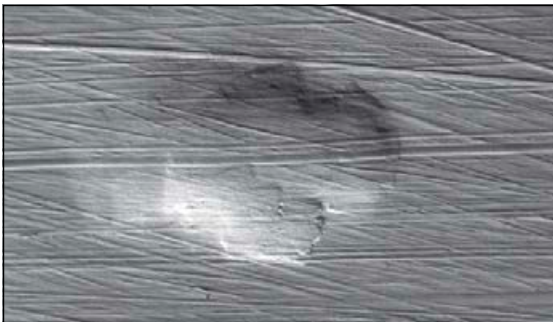


Fig. 8. This photo, taken with a microscope, shows a debris contamination bruise on a bearing race. A corresponding surface map of the dent is shown in Fig. 9

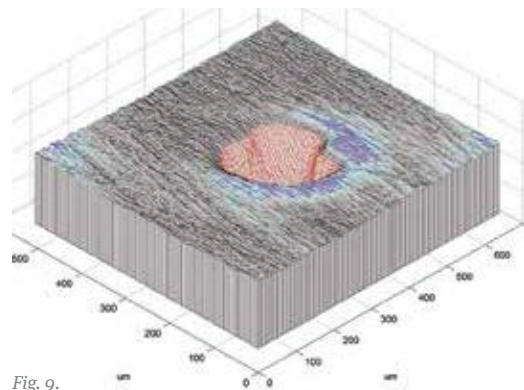


Fig. 9.

WEAR – GROOVING

Extremely heavy wear from chips or metal particles can cause grooving. These contaminants become wedged in the soft cage material and cut grooves in the rolling elements. This condition generates improper rolling contact geometry and can reduce service life.



Fig. 10. Large particle contamination imbedded into the soft cage material can result in grooving and circumferential lining of the rollers and raceways



Fig. 11. Horizontal grooves cause improper rolling contact, reducing bearing life

ETCHING – CORROSION

Etching (or corrosion) remains one of the most serious problems anti-friction bearings encounter. Without adequate protection, the high degree of surface finish on races and rolling elements makes them susceptible to corrosion damage from moisture and water. Etching is most often caused by condensate collecting in the bearing housing from temperature changes. Moisture or water can get in through damaged, worn or inadequate seals. Improperly washing and drying

bearings when you remove them for inspection also can cause considerable damage. After cleaning and drying or preparing bearings for storage, you should coat them with oil or another preservative and wrap them in protective paper. You should always store bearings, new or used, in a dry area and keep them in original packaging to reduce the risk of static corrosion appearing before mounting.

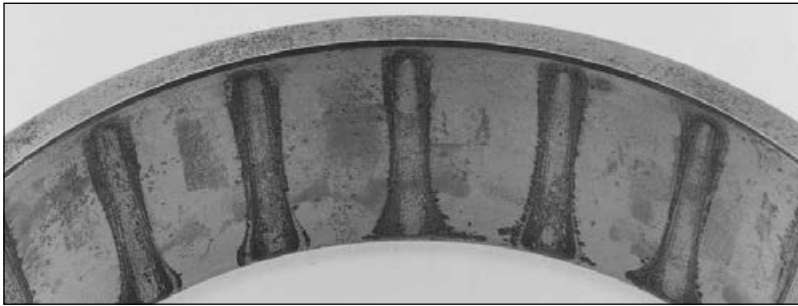


Fig. 12. This cup has heavy corrosion on the race. This type of corrosion may only be a surface stain without pitting. If the staining can be cleaned with a fine emery cloth or crocus cloth, the bearing may be reused. If there are pits that cannot be cleaned with light polishing, the bearing should either be discarded or, if practical, refurbished



Fig. 13. This cylindrical bearing inner ring has etching and corrosion



Fig. 14. Advanced spalling initiated at water etch marks on the cup race makes this bearing unsuitable for further service



Fig. 15. Heavy water damage is shown on this ball bearing inner ring and cage



Fig. 16. This ball bearing outer race also depicts etching and corrosion

INADEQUATE LUBRICATION

Inadequate lubrication can create a wide range of damage conditions. Damage happens when there isn't a sufficient amount of bearing lubricant to separate the rolling and sliding contact surfaces during service. It's important that the right lubricant amount, type, grade, supply system, viscosity and additives be properly engineered for each bearing system. Base your selection on history, loading, speeds, sealing systems, service conditions and expected life. Without proper

consideration of these factors, you may experience less-than-expected-bearing and application performance. The damage caused by inadequate lubrication varies greatly in both appearance and performance. Depending on the level of damage, it may range from very light heat discoloration to total bearing lockup with extreme metal flow.

The following section outlines the progressive levels of bearing damage caused by inadequate lubrication:

LEVEL 1 – DISCOLORATION

- Metal-to-metal contact results in excessive bearing temperature.
- High temperatures result in discoloration of the races and the roller.
- In mild cases, the discoloration is from the lubricant staining the bearing surfaces. In severe cases, the metal is discolored from high heat.

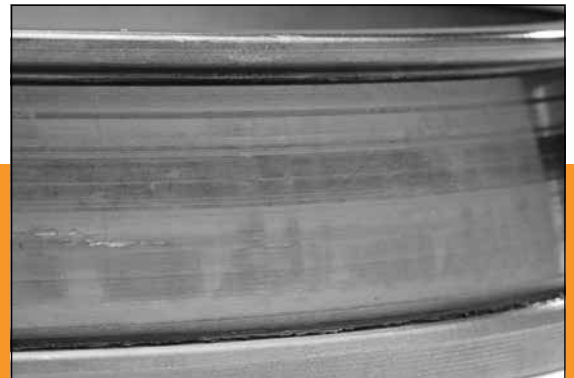


Fig. 17. Level 1 – Discoloration due to elevated operating temperatures

LEVEL 2 – SCORING AND PEELING

- Insufficient or complete lack of lubricant.
- Temperature changes.
- Selecting the wrong lubricant or lubrication type.
- Sudden changes in running conditions.

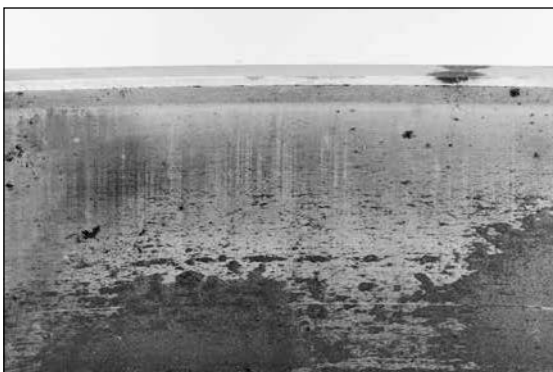


Fig. 18. Level 2 – Micro-spalling or peeling results from thin lubricant film due to high loads/low revolutions per minute (RPM) or elevated temperatures



Fig. 19. Level 2 – Advanced rib scoring is due to inadequate lubricant film

FATIGUE SPALLING

Spalling is the pitting or flaking away of bearing material. Spalling primarily occurs on the races and the rolling elements. We show many types of “primary” bearing damage throughout this reference guide that eventually deteriorate into a secondary spalling damage mode. We classify three distinct spalling damage modes:



Fig. 23. Misalignment, deflections or heavy loading on this tapered roller bearing caused GSC spalling.

Causes for this type of damage mode include misalignment, deflection or edge loading that initiates high stress at localized regions of the bearing. It occurs at the extreme edges of the race/roller paths. It also can be the end result of shaft or housing machining errors.

POINT SURFACE ORIGIN (PSO) SPALLING

Very high and localized stress generates this type of damage mode. The spalling damage is typically from nicks, dents, debris, etching and hard-particle contamination in the bearing. It's the most common type of spalling damage, and it often appears as arrowhead-shaped spalls, propagating in the direction of rotation.



Fig. 24. PSO spalling resulted from debris or raised metal exceeding the lubricant film thickness on this tapered roller bearing inner ring

INCLUSION ORIGIN SPALLING

This damage occurs when there's bearing material fatigue at localized areas of sub-surface, non-metallic inclusions following millions of load cycles. A sign of this damage appears in the form of localized, elliptically shaped spalls. Due to the improvement of bearing steel cleanliness during the past two decades, it may be unlikely you will encounter this type of spalling.



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EXCESSIVE ENDPLAY

Excessive preload can generate a large amount of heat and cause damage similar in appearance to inadequate lubrication damage. Often the two causes may be confused, so you need to check the bearing thoroughly to determine the root problem. A lubricant that's suitable for normal operation may be unsuitable for a heavily preloaded bearing, as it may not have the film strength to carry the very high loads. The lubricant breakdown in high preloads can cause the same type of damage shown in the previous description of inadequate

lubrication damage on page 10. Another type of damage can result from heavy preloads even if you use a lubricant (such as an extreme pressure type of oil) that's engineered to carry heavy loads. Although the lubricant can handle the loads so that there's no rolling element or race scoring, the heavy loads may cause premature sub-surface fatigue spalling. The initiation of this spalling, and subsequently the life of the bearing, would depend on the amount of preload and the capacity of the bearing.



Fig. 25. Heavy spalling and fracturing from high loads on this spherical roller bearing



Fig. 26. High loads resulted in fatigue spalling on this cylindrical roller bearing



Fig. 27. This ball bearing inner ring depicts fatigue spalling from high loads. The fracture is a secondary damage mode



Fig. 28. Overloading on this cylindrical roller bearing caused roller surfaces to fracture



Fig. 29. High loads and low speeds caused insufficient lubricant film on this tapered roller bearing cone



Fig. 30. A heavily overloaded tapered roller bearing resulted in premature, severe fatigue spalling on the rollers. The load was so heavy that large pieces of metal broke off the rollers

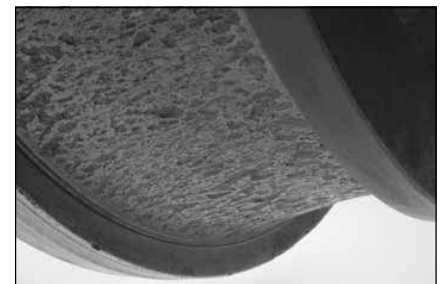


Fig. 31. This spherical roller bearing race shows severe peeling and spalling due to high loads

EXCESSIVE ENDPLAY

Excessive endplay results in a very small load zone and excessive looseness between the rollers and races outside the load zone. This causes the rollers to unseat, which leads to roller skidding and skewing as the rollers move into and out of the load zone. This movement creates scalloping in the cup race, and cage wear from excessive roller movement and the impact of the rollers with the raceway.



Fig. 32. Scalloping marks in the cup are common with excessive endplay. This occurs when unloaded rollers enter the small load zone and are suddenly exposed to heavy loads



Fig. 33. Cage pocket damage results from excessive roller movement



Fig. 34. Heavy wear in the small end of the cage pockets is typical of excessive endplay

MISALIGNMENT AND INACCURATE SEAT AND SHOULDER MACHINING

Misaligned bearings will shorten bearing life. This reduction depends on the degree of misalignment. To gain more life from the bearing, the seats and shoulders supporting the bearing must be within the specified limits set by the bearing manufacturer. If the misalignment exceeds those limits, the load on the bearing won't be distributed along the rolling elements and races as intended. Instead, it will be concentrated on only a portion of the rollers or balls and races. In cases of extreme misalignment or off angle, the load will be carried only on the extreme ends of the rolling elements and races.

A heavy concentration of the load and high stresses at these points will cause early metal fatigue.

TYPICAL CAUSES OF MISALIGNMENT:

- Inaccurate machining or wear of housings or shafts.
- Deflection from high loads.
- Out-of-square backing shoulders on shafts or housings

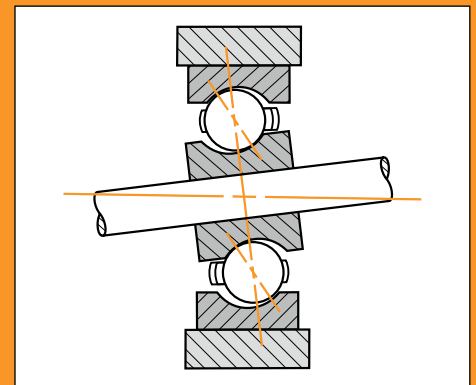


Fig. 35A. Shaft misalignment

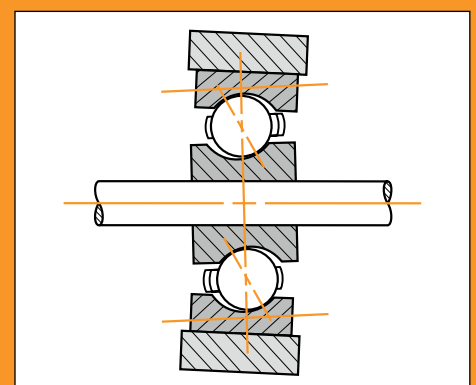


Fig. 35B. Housing misalignment

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TRAINING

THORDON

A PORTRAIT OF THE ARTIST *AS A YOUNG MAN*

Although George ‘Sandy’ Thomson has, as is tradition, handed the company reins down to a younger family member (step-daughter Anna Galoni), he will still have an important role to play in the family-owned Thomson-Gordon Group, the Canada-based parent of Thordon Bearings. His business card reads simply “Innovator”.



*George 'Sandy' Thomson
"Innovator" at Thordon Bearings*



Indeed, if there is just one verb that defines Sandy's adult life it would be the verb "to create". Whether it be creating music on the vibraphone with a Cuban jazz band, making acclaimed documentary films or pioneering the development of a unique polymer bearing, creation has been at the forefront of most things Sandy has been involved with.

"I am an engineer but in my heart, I

am an artist" he says, suggesting that for engineers to succeed in business they need to merge the mathematical, rational, logical left side of the brain, with the intuitive, thoughtful, and subjective right. "Ultimately, you have to be crazy" he says, with a smile.

After graduating in mechanical engineering from Northrop University and a subsequent stint as a mechanical

seals engineer, Sandy entered the family business in the 1960s, where he began his pioneering work reacting synthetic elastomer chemicals.

"I'd met this Indian rubber chemist, Dr Pandi, and we'd spend days blending these newly discovered polymers to see if we could find different uses for them. Eventually, we came up with the right formula and manufactured the world's first polymer alloy pump bearing."



After the market success with the new bearing technology in industrial applications, Sandy and Pandi set about developing polymer bearings for seawater-lubricated propeller shafts, which, at that time, were either lignum vita bearings or phenolic laminate (resin). A polymer material, he thought, would make the bearing more abrasion resistant and less susceptible to damage in high temperature, high pressure applications. "Traditional phenolic laminate-based seawater-lubricated bearings just don't have the longevity of a polymer system."

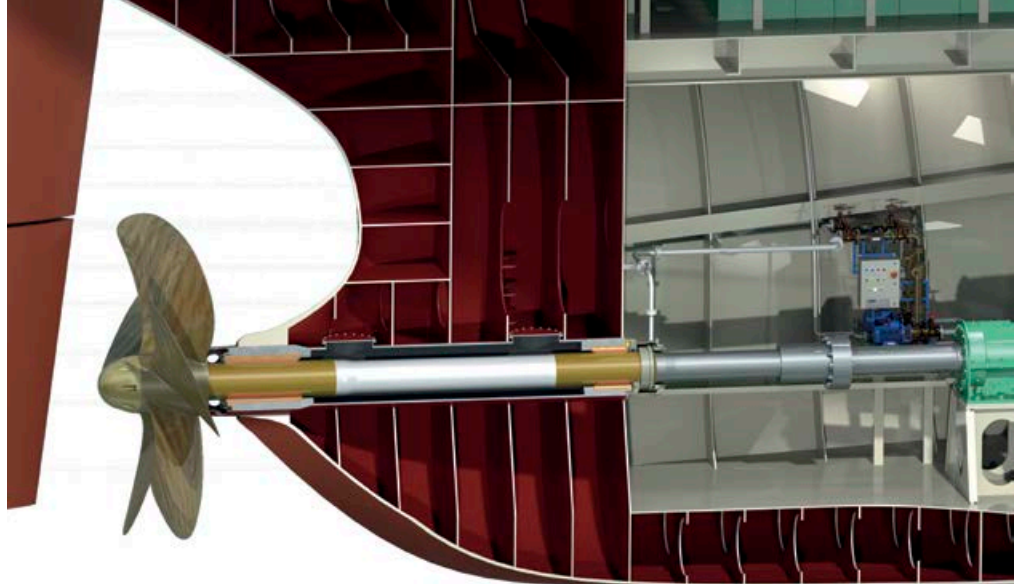
One thing that differentiates Thordon Bearings from its competitors is a business model devoted to innovation. "We don't look to see what our competitors are doing and say, 'hey let's make one of those'. We invent the solutions that our competitors

want to copy. Our material scientists, technologists and engineers, some of the best in the world, just work on new ideas, new concepts. They're creative people. It's like a Google environment which, for a company our size, is quite an achievement. If we can't better something that's already out there, why do it? Our philosophy is to make systems and technologies that last a life-time."

Combined with a commitment to safeguarding the environment, this philosophy has provided the fulcrum on which the company pivots since 1967, when Sandy's father, George J.V. Thomson, an architect graduate from Pratt Institute of New York, passed the running of the company to his eldest son.

This rite of passage has been a family tradition dating back to 1911, when

Major George J. Thomson along with brother William started an industrial distribution business in Hamilton, Canada. Earl Gordon later joined them in partnership and following incorporation of the company in 1916, the name Thomson-Gordon Ltd. was adopted.



George and Earl steered their company towards manufacturing in a variety of applications before passing the running of the business to George's son, George J.V. Thomson, who later gave his son, Sandy, the chance to change the company's direction and implement changes that would result in the Thordon Bearings we know today. Distributed products were dropped and focus shifted to supplying its own in-house designed and manufactured polymer bearings and seals for marine and industry.

Thordon Bearings Inc. was incorporated in 1990, the same year Sandy purchased Rudokop, a Russian deep sea salvage tug, which he converted into a "floating showcase" of Thordon's marine bearing and seal products. For 14 years, Sandy captained the vessel, visiting more than 200 international ports promoting polymer bearings to the industry leaders and the shipping community.

"To some business gurus, striving for quality doesn't necessarily make the best business model, since it limits the potential for tapping in to a lucrative after sales market," Sandy says. "This type of business model is favoured by manufacturers of phenolic-laminate bearings because their products are not known for longevity and have to rely on the after sale of spare parts and maintenance services.

"When we tested our polymer bearings against bearings made from phenolic laminate-based materials the difference was dramatic. We found that these types of bearings have life spans of between three to five years before they need replacing. Although, a phenolic laminate system may be the cheaper



solution, when you factor in replacement parts, mechanical breakdowns and maintenance, our bearing systems pay for themselves,” Thomson claims.

Thordon’s polymer technologies are now used in myriad industrial applications, such as marine, oil and gas, and power generation systems, with the company’s bearing and seal products achieving particular success as grease-free, maintenance free, environmentally safe alternatives to traditional bearings. The aviation business also uses Thordon materials and has adapted them for bearings for aircraft landing gear positions.

“There is no limit to the possibilities of what we can achieve with our

polymer technology. The challenge is coming up with new, fresh ideas but that will be my main role now that I have essentially retired from the day-to-day running of the company.”

His step-daughter Anna Galoni, a Polish-born epidemiologist, is now fully ensconced in the family-owned business and beginning to implement a plan that will see the company expanded its diverse portfolio to new markets.

Sandy’s devotion to innovative engineering was rewarded last year when he was elected a Fellow of the Society of Naval Architects and Marine Engineers (SNAME).

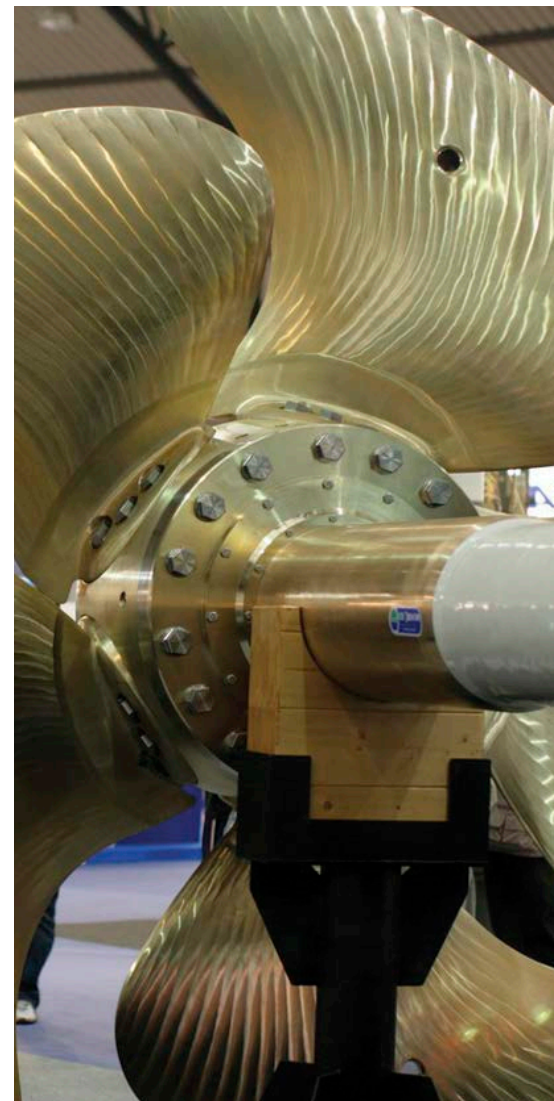
“I was humbled to be elected,” he

says. “It was great honour.”

According to the Society, the grade of Fellow is accorded exclusively to “individuals who have made outstanding personal contributions to naval architecture, marine or ocean engineering, or allied disciplines through significant achievements in design, research, production, operation, education or associated management.”

Sandy’s creative passions, strong leadership and innovation transformed the company into a successful marine and industrial bearing and seal manufacturer, which today is widely considered the world leader in non-polluting oil and grease free bearings and seals.







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LOOKS INTO THE FUTURE

The EMEA industrial distribution markets' competitive landscape is changing quickly. Managers need to look ahead and be able to identify the opportunities and challenges in due time, sometimes within very short timeframes. A constant long term vision should be sustained by fast decisions when opportunities arise.

Methods used in the past may not work anymore and in order to keep up with the force of change, an enterprise has to mobilize all its resources. There is where the enthusiasm, energy, and new ideas of young management teams can make a competitive advantage.

Proving its commitment to growing the talent of the future and to continuous people development, EPTDA hosts every year since 2010 a special Next Generation (NexGen) event at the Annual Convention, the NexGen seminars. After the successful NexGen Forums & Contests in the past Annual Conventions, that have created a structured community from

programmes every year in March at its All Committees' Days meetings, based on the actual challenges from the market in order to engage this young audience to the next level. These events organised as a one day workshops are created to advance young managers' ability to think outside the enterprise's historical business planning methods to better plan for the future. Besides the opportunity to network with peers, learn innovative management approaches and exchange ideas on how to plan best and prepare for the ongoing disruptive markets and conditions that will shape the next 30 years of their career and business cycles globally.

NEXGEN managers are invited to strengthen their knowledge about key concepts that will enhance their skills and business practices, and thus reaffirming their values and commitment to their company.

Involving the Next Generation in the association's committee work is another way to facilitate the exchange between the



At these Spring meetings, EPTDA's NexGen participants can mingle with the association's leaders and volunteers and get to know about the latest developments in the industry. Again this year in Rome, we expect more than 50 NexGen representatives to be present and take part in the NexGen Seminar and Workshop, which are now an integral part of the association's Convention programme.

Hans Hanegreefs | Executive Vice President of EPTDA

all NexGen Delegates, EPTDA has formed a NexGen Taskforce who is constantly looking into finding new innovative ways to stimulate and develop the future leaders of the PT/MC industry.

The main objectives of this orientation are meant to raise awareness about what Next Generation means for the industry and create a structured workgroup, acknowledging their value and contribution.

Besides the dedicated NexGen programme held each year at the association's annual conventions, EPTDA strives to organize thought-provoking Next Generation education

generations of managers of top companies in the industry while bringing their own contribution to creating value and challenging the way decisions are made.

Last but certainly not least, young managers know the importance of real time communication so EPTDA is eager to make their voices heard. Already active on EPTDA's social media channels, this experience will be leveraged in the next future to an industry online platform where EPTDA members can use the power of the community to find together innovative solutions to keep decisions upstream and make each challenge a growth opportunity.

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The 4 conference themes are:

→ Bearing Applications and their Maintenance
→ Lubrication

→ Industrial Maintenance and Reliability
→ Prediction and Planning in Maintenance



Industrial Maintenance and Reliability

Presentation

The Bearing Industry, Value First Then Price

Todd Snelgrove

Global Vice President of Value SKF



Prediction and Planning in Maintenance

Presentation

The Global Predictive Maintenance Sphere

Chris Hansford

Managing Director and Owner of Hansford Sensors



The opening conference presentation will be delivered by Todd C. Snelgrove. Todd is what is referred to as a Global Value Merchant, always advocating the power of Increasing You and Your Customer's Bottom Line by demonstrating, documenting, procuring, pricing and selling based on best Total Profit Added™.

Global Vice President of Value with over 15 years' experience in being the team leader on understanding, presenting, calculating pricing, and purchasing on Total Cost of Ownership (TCO) or Total Profit Added™ (TPA™), Todd is acknowledged to be a leading subject matter expert in the field of value.

Why talk about Value in the Industrial Maintenance and Reliability World?

Simply put - the bearing is the heart of our rotating equipment and if the bearing fails in any form then the reliability of our equipment starts to suffer and so does our financial performance, from the slightest of lost or wasted revenue to the possibility of a catastrophic effect on the balance sheet.

It makes little difference if we are users of bearings, manufacturers of bearings, suppliers of bearings or suppliers of bearing related performance and reliability technologies, our tasks are all VALUE related. The value chain is only as strong as its weakest link and Todd will explore with us how our own contributions will ultimately improve bearing and equipment reliability.

Bearing and equipment reliability can be improved and bottom line profits can be maximized, however the opposite is also true, bearing and equipment reliability can be decreased and bottom line profits damaged. The key to improved reliability is what one does to the equipment and the bearing or how we treat them during their operational lifetime. It is all about care, the care we apply to the machine or product and in particular, knowing when to apply the care or actions needed to safeguard or protect equipment life.

Predictive Maintenance or Pdm as it is often called, is an important ingredient of any maintenance and reliability strategy, because without it one will never know that the machine has problems until it's too late. Pdm employs technologies like vibration and bearing monitoring, oil analysis, thermography, ultrasonics,... to name a few.

The key to any successful Pdm strategy is knowing what technologies to employ and how to go about employing them and we are fortunate at this year's BRCE event to have a truly global guru to address us in this sphere, Chris Hansford.

Chris Hansford is the Managing Director of Hansford Sensors Ltd., a qualified Electro-Mechanical Engineer and has over 35 years experience in vibration and condition monitoring. Chris Hansford is a speaker about predictive maintenance that we all should hear, he has a wealth of knowledge about the developments and trends in the global condition monitoring sphere. He will also set the scene for the 5 Pdm experts who will present directly after him.



**02
DAY
AFTERNOON**

Bearing Applications and their Maintenance

Presentation

The Global Bearing and Maintenance Trends

Wim Vancauwenberghe

Director BEMAS (Belgium Maintenance Association)

The importance of the bearing in any rotating machine, is like power in our home, the on/off switch to all our appliances and food for our bodies. Simply put, if the bearing doesn't operate correctly, neither does the machine.

Bearings come in all shapes, sizes and configurations – designed to meet the most arduous or toughest operational environments or simply to provide a trouble free machine for the entirety of its life. However, reliable bearing functionality is also dependent on how we treat the equipment, how we operate it, how we maintain it and how we lubricate it. This is maintenance.

Maintenance technologies and strategies vary greatly; they are more often than not dependant on the application, the required machine reliability and the operational environments and we have seen over the years an evolution and in some cases a revolution, in available or employed maintenance strategies. Ranging from fix it when its broke to all forms of diagnostics and control driven strategies, for example like the current evolution of Industry 4.0.

For the Maintenance Manager, Reliability Engineer, Maintenance Forman / Supervisor or just the Mechanic, knowing what strategy to employ for one's own equipment is a complex time consuming issue and if we get it wrong it can be a very expensive lesson. To lead the session on Bearing applications and their environment, we are extremely fortunate to have a Maintenance knowledge expert that can put logic into our understandings and strategy selection processes. Wim Vancauwenberghe will lead and guide us through this section of the conference.

Wim Vancauwenberghe is the Director of BEMAS, the Belgian Maintenance Association and has held this position since 2000. He holds a master degree in industrial engineering and is Certified Maintenance & Reliability Professional by SMRP.



**03
DAY
STARTING**

Lubrication

Presentation

The Lubrication Role in Machine Reliability

Ian Knight

Managing Director and Key Owner Enluse BV

Wear is defined as being caused by the relative motion between two surfaces that are in close contact, causing deformation or removal of the material; this known as mechanical wear. Wear can also be caused by other sources such as harsh or reactive chemicals, or cavitation.

This definition of mechanical wear is well known within our industry and we also understand that friction and wear can be reduced through the application of a lubricant; however what is not so commonly understood is how lubrication and it's application, effects the level of equipment wear. Today with bearings in many applications, life can be infinite, in other words bearings just don't wear out.

Mechanical wear can be predominantly defined as Abrasive Wear and Adhesive Wear. Abrasive wear is related to the cleanliness of the lubricant and Adhesive Wear is related to the metal to metal contact of the moving components due to a loss of the lubricants viscosity.

This section of the conference addresses the causes of mechanical wear and offers lubrication solutions / strategies to eliminate them. We are fortunate to have a very experienced bearing person present this conference sector and set the scene for the speakers that will follow. Ian Knight from Enluse BV.

Ian Knight is the principal owner and director of Enluse BV in the Netherlands. Enluse is an organization that began in 2003 and one that specializes in the supply of products and knowledge to help companies improve their plant lubrication practices. Prior to starting Enluse Ian worked for the SKF organization for more than 30 years always in the fields of service, sales and equipment reliability. Ian is an accomplished presenter and very competent in the fields of bearing lubrication and equipment reliability. He is a must to listen to.

THE SCENE IS SET FOR A GREAT CONFERENCE

Beside the 4 key note speaker presentations and 16 global bearing and reliability presentation. There will be 8x workshop style sessions in the networking area for the exhibition public.

TOP SPEAKERS

AT THE BRCE CONFERENCE

Todd C. Snelgrove



The Bearing Industry:
Value First then Price

Dan Bradley



Bearing Reliability
- It is a Journey

Per Arnold Elgqvist



Making Bearings Reliable

David Wilbur



Admitting Human
Error in the Workplace
- Maximizing Asset Reliability
with Human Factors

Chris Hansford



The Global Predictive
Maintenance Sphere

Dieter Charle



Cut through the complexity
of Machinery Analysis with
High Frequency Vibration Analysis

Matthias Winkler



Where can condition
monitoring fail?



Gwyn Simmonds



Fluid Analysis for
Bearing Reliability

Trinath Sahoo



Bearing failure due to poor
lubrication and contamination,
Causes and Cures

Wim Vancauwenberghe



The Global Bearing and
Maintenance Trends

Martin Blenkers



Bearing Reliability,
Outsource or do it Yourself

Robin Ottenfelt



The Digital Evolution for
the Maintenance and
Service Industry

Pietro Prosino



The Importance of
Heat Treatment in Precision
Bearing Applications

Martin Deiss



Protecting VFD Driven Motors
from Bearing Currents

Ian Knight



The Lubrication Role
in Machine Reliability

Haris Trobradović



Taking the CMMS
out of lubrication

Kees Veltman



Why Preventive/Proactive
Maintenance

Martin Williamson



Best Practices in
Lubrication Training
-
Filtration for Improved
Bearing and Equipment Life

CONFERENCE AGENDA

DAY 01

10 OCTOBER

Morning Theme:
Industrial Maintenance and Reliability

- 13:15 ● Key Note Address:
The Bearing Industry Value First then Price
Todd C. Snelgrove
- 14:15 ● Session Topic
Bearing Reliability - It is a Journey
Dan Bradley
- 15:00 ○ COFFEE BREAK
- 15:15 ● Session Topic
Reliability at Heinz Foods
Darren Maloney
- 15:45 ● Session Topic
Making Bearings Reliable
Per Arnold Elqvist
- 16:15 ● Session Topic
Admitting Human Error in the Workplace - Maximizing Asset Reliability with Human Factors
David Wilbur

DAY 03

12 OCTOBER

Morning Theme:
Prediction and Planning in Maintenance

- 08:30 ● Key Note Address:
The Lubrication Role in Machine Reliability
Ian Knight
- 09:30 ● Session Topic
Taking the CMMS out of lubrication
Haris Trobradović
- 10:00 ○ COFFEE BREAK
- 10:15 ● Session Topic
Why Preventive/Proactive Maintenance
Kees Veltman
- 10:45 ● Session Topic
Best Practices in Lubrication Training
Martin Williamson
- 11:15 ● Session Topic
Filtration for Improved Bearing and Equipment Life
Martin Williamson
- 11:45 ● **Closing Ceremony**
12:00

DAY 02

11 OCTOBER

Morning Theme:
Prediction and Planning in Maintenance

- 08:30 ● Key Note Address:
The Global Predictive Maintenance Sphere
Chris Hansford
- 09:30 ● Session Topic
Cut through the complexity of Machinery Analysis with High Frequency Vibration Analysis
Dan Bradley
- 10:00 ○ COFFEE BREAK
- 10:15 ● Session Topic
Where can condition monitoring fail?
Matthias Winkler
- 10:45 ● Session Topic
Fluid Analysis for Bearing Reliability
Gwyn Simmonds
- 11:15 ● Session Topic
Bearing Failure Analysis for Improved Reliability
David Beattie
- 11:45 ● Session Topic
Bearing failure due to poor lubrication and contamination, Causes and Cures
Trinath Sahoo

12:15 ○ LUNCH BREAK

13:15 ● **Afternoon**
Prediction and Planning in Maintenance

- 13:30 ● Session Topic
The Global Bearing and Maintenance Trends
Wim Vancauwenberghe
- 14:30 ○ COFFEE BREAK
- 14:45 ● Session Topic
Bearing Reliability, Outsource or do it Yourself
Matthias Winkler
- 15:15 ● Session Topic
The Digital Evolution for the Maintenance and Service Industry
Robin Oldenfelt
- 15:45 ● Session Topic
The Importance of Heat Treatment in Precision Bearing Applications
Pietro Prosino
- 16:15 ● Session Topic
Protecting VFD Driven Motors from Bearing Currents
Martin Deiss

19:30 ● **Evening**
Conference Dinner & Entertainment
Room Goldsaal
Hosts: Dan Bradley and Ian Knight

8

FREE WORKSHOPS AT THE BRCE EXPO AREA

This year at the BRCE event we are not only running a conference with high quality speakers in all aspects of Bearing Reliability and Maintenance. We are also opening up the exhibition area to the public with 8x workshop style sessions which will cover the following topics:

1. Understanding and using vibration sensors
2. Conducting machine alignment for improved machine performance
3. Using High frequency acoustics to control lubrication
4. Understanding viscosity and keeping your oil in a good working condition
5. Implementing Lubrication reliability
6. RCA an important ingredient of proactive maintenance
7. Bearing Failure Analysis
8. Bearing maintenance – the right tools for the job



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FOR VISITORS

BEARING FAILURE ANALYSIS

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- How to recognize these 12 bearing failure modes by examining damage bearing wear patterns
- Corrective actions to prevent the 12 failures from reoccurring
- Visitors can also bring their own failed bearings and Per Arnold will analysis them
- Visitors attending this workshop can get a -50% discount on the online course about bearing failure analysis

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Ian Knight

Paper & Presentation Submissions

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Kenan Özcan

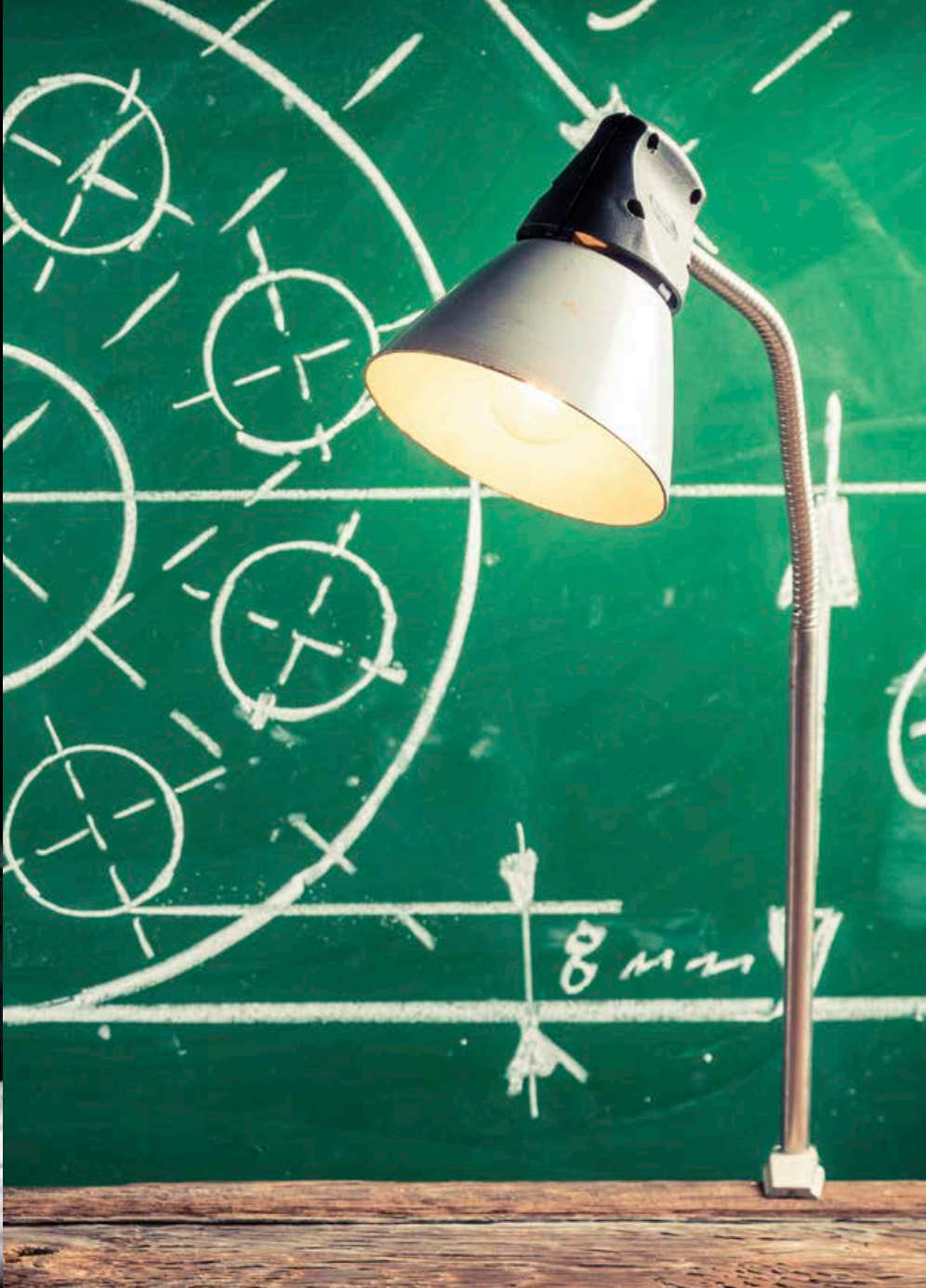
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vol.03

TOP10 TIPS_{for} BEARING REABILITY

by Mr. Per Arnold Elgqvist



BearingTip No. 1: When and why should we use solid additives in lubricants?

Solid additives like graphite, molybdenum disulfide, Teflon and others are most useful but only in certain applications where they really are necessary: Low speed combined with high loads.

When the speed of the rolling elements in their contacts on the raceways of the rings are too low, the elasto-hydro-dynamic lubrication has difficulties to form a sufficient lubricating film thus allowing metal to metal contacts. This is when solid additive in the form of laminar particles can form an additional layer avoiding this direct metal to metal contacts. Low speed must be indicated as

Speed Factor, being the product of the rotating speed (n) in RPM and the mean bearing diameter being the outer diameter plus the inner diameter divided by 2, $(D + d)/2$. Using this concept low speed is when the values of the speed factor is less than 20,000. When solid additives are used by mistake in lubricants for bearings running at high speeds, the effect of the solid additives will eliminate the internal clearances

and generate friction and increased temperature. Below pictures are from a real case story: Bearings 6215 and 51115 in a vertical pump running at 3600 RPM. This means a speed factor of 138,600. These 2 bearings got overheated and lasted for only 48 hours when lubricated with a grease with 460 centistoke base oil plus molybdenum bisulfide! Additional comment: Look for the cage of the bearing 6205. When the lubrication



fails, the cage is normally the first to fail as it is the weakest component of the bearing plus that the rolling elements are sliding against the cage, not rolling!

BearingTip No. 2: Bearing that got corroded in the warehouse can't be restored to achieve the required reliability!

Bearings are precision components and must be taken care of as such. As the corrosion cannot be eliminated without affecting their precision it must be avoided. Even the slightest polishing will affect the dimension as this is in microns, and even worse, the particles of rust and the abrasive media used easily will contaminate the bearing and cause severe wear. This means that bearings found with corrosion in the warehouse should not be used. Thus, it is recommended to perform an effective control of the bearings in the warehouse: First at the Receive Control to guarantee that the supplier deliver bearings in perfect condition. Second that the bearings are kept in the warehouse in unopened packages and in such conditions that corrosion or any other damage will be avoided.

As the reliability of the bearings starts in the warehouse (the right bearings and in perfect conditions) it is recommended to perform a physical inventory once a year in order to assure their conditions. At this, all bearings found with corrosion should be eliminated. Obsolete bearings not needed any longer should be eliminated immediately and bearings that are needed as spare parts should be eliminated as soon as new replacement bearings in perfect conditions have arrived. And I mean definitively eliminated, not kept for "in case of", see the right photo.

Do the bearings in the below photos inspire reliability to you?

BearingTip No. 3: Best practices for manual lubrication is to use greases in cartridges.

A very common problem I have found is that manual grease pumps are filled by hand directly from the grease container: From an 18 kilos bucket or even worse, from a 180 kilos drum! This may cause 4 serious problems that will affect the reliability of the bearings:

1. You cannot assure a perfect filling of the pump. Air that enters will cause variation of the quantities of the injected grease into the bearing applications.

2. The grease inside the container is very clean when it is opened for the first time, but being opened many times (at least 45 times for a bucket and 450 for a drum for filling 400 ml grease guns), or even



worse, being left open as "I will return in a few minutes". What opportunities for contamination of the grease!

3. If the lubrication route is very long, the lubricator must carry the bucket around or return to the place where it is stored every time the manual pump gets empty.

4. There is also a risk of mixing different incompatible greases if the manual pump is not clearly identified for which grease it is to be used.

All these problems are avoided when you use grease in cartridges or a cap with an integrated pump on the bucket or the drum as shown below!



BearingTip No. 4: Hybrid bearings offer many advantages!

Hybrid bearings are those with rolling elements made of other material than

bearing steel, i.e. ceramic material (silicon nitride). These were first intended for bearing applications in electrical machinery where there is a risk for electrical erosion due to passage of electric current, but has now also become standard for high precision bearings.

This problem has increased substantially with the electrical motors with variable speed. But then it has been found that these bearings have several additional advantages besides the insulating properties:

Lower density: The density of the ceramic material used is 60% than bearing steel. Lower weight means lower inertia and that translates into superior behavior during rapid starts and stops, as well as higher speed capabilities.

Lower friction: The lower density of the ceramic rolling elements, combined with its low coefficient of friction, significantly reduces bearing temperature at high speeds. Cooler running extends the service life of both the bearing and the lubricant.

High hardness and high modulus of elasticity: The higher hardness of the ceramic rolling element means higher resistance against wear which means longer bearing service life in contaminated environments and the higher modulus of elasticity increase the stiffness of these bearings.

Higher resistance against false brinelling: When stationary bearings are subjected to vibrations there is a risk that "false brinelling" occurs. False brinelling is the formation of shallow depressions in the raceways according to the form of the rolling elements by the impacts of these that with the time lead to spalling and premature bearing failure. When rolling elements made of bearing steel are replaced by ceramic rolling elements, the bearings are significantly less susceptible to false brinelling.

Less thermal expansion: Ceramic rolling elements have a lower coefficient of thermal expansion (one third) than rolling elements made of bearing steel. This means less sensitivity to temperature gradients within the bearing and more accurate preload/clearance control.

Higher speed capability: Typically, hybrid bearings have a higher speed capability than bearings with steel rolling elements, however, in some cases, the cage execution may limit the attainable speed.

These advantages have now made the hybrid bearings most popular for other applications besides electrical machines, specially in high speed spindles in machine tools.

At first these hybrid bearings were most expensive, but with the increased volume being used more and more for machine tools the manufacturing cost has gone down making these bearings more affordable.

BearingTip No. 5: The main cause for failure of electrical motors is the failure of their bearings.

Bearing failures are without doubt the most common cause for the failure of electric motors, and the main reason for the failure of these bearings is inadequate lubrication. The lubrication may be inadequate for various reasons. The most common is wrong grease, due to wrong viscosity of its base oil, its temperature range, solid additives that are unnecessary and even harmful in this application,



wrong consistency or low quality of the grease, excess of grease or too little.

Low quality of a grease will in most cases cause the loss of the consistency due to low mechanical stability and the grease will turn liquid and escape from the bearing leaving this without lubricant. Other causes for the failure of the lubrication are wrong quantities of grease, being the most common

the excess that leads to increased temperature that destroys the grease. Too little grease will naturally lead to starvation of the lubrication. The mix of incompatible greases is also common and this also causes softening of the grease.

All this causes are due to lack of knowledge. Unfortunately, still today the lubrication is given very little importance. But we must see this as a huge opportunity, as the training in this matter will pay off incredibly and in a very short term.

See the below case: A deep groove ball bearing in the motor in a continuous mining equipment running got hot and destroyed the grease. The cooling oil circulation system was shut down at the same time as the machine in spite of the instruction to leave it working for 20 minutes after the shutdown of the machine in order to cool down the bearing.

BearingTip No. 6: Combine different predictive technologies to obtain the maximum benefits.

“Which technology is the most useful”? This question is too often made when companies are to start predictive maintenance. The right answer is “Do not generalize in this form”. Each and every one of the technologies for predictive maintenance has advantages and limitations and the benefits will very much depend of the different type of equipment in the process of the corresponding plant.

In order to optimize the benefits of the predictive maintenance the very best solution is to determine the most adequate technology for the different applications, but the very



best solution is to combine different technologies for the same equipment.

A practical example: Industrial gearboxes. For this application, the optimum benefits will be obtained combining oil analysis and vibration analysis. Vibration analysis is more complicated in this application due to the complexity of this equipment with several gears and bearings with a huge number of different vibration frequencies and amplitudes. But oil



analysis will advise as soon as wear particles are found indicating initiating problems. But it will not tell which gear or bearing is having wear problems but will give the alarm according to the oil sampling program. Having identified this alarm, it is the opportunity to make a detailed vibration analysis to determine which gear and/or Bearing is starting to have problems. With this information, a precision maintenance can be planned in lieu of taking the gearbox into pieces to look for the damage.

BearingTip No. 7: Be most careful with the installation of the equipment on the field.

I have had several cases where new bearings mounted in repaired electrical motors have been perfect as the motor is delivered from the own electrical repair shop or from external repair shops, but

rejected due to bearing damage reported by the predictive maintenance at the very first vibration analysis.

In all these cases the damage to the bearings were caused by axial forces and/or impacts applied onto the shaft during the mounting of the transmission component on the shaft end by mechanics on the field. In every case the electric repair shop was accused as guilty for the bearing damage. These damages are easily avoided.

Other typical case was a misaligned bearing in a centrifugal pump. The repair shop insisted that the pump has been perfectly aligned. But then it was discovered that the outlet tubing had been tensioned to assemble which led to the misalignment of the pump. Conclusion: The same care must be taken when installing the equipment as when mounting the bearings and assembling the equipment.

BearingTip No. 8: Polyamide cages should not be used in centrifugal pumps in the oil industry.

According to the Standards API 610 and ISO 13709 machined brass cages must be used in centrifugal pumps in the oil processing pumps. This Standard also tells that “nonmetallic cages shall not be used”. Why is this?

Nonmetallic cages mean polyamide cages. These are standards today in many applications so why not in



these applications? The answer is very simple: They do not advise making noise when the bearing is starting to fail. Polyamide cages may last longer than other in many applications, but due to the nonmetallic material they do not make noise when they start to fail, which means that the failures may reach catastrophic levels which is most dangerous in pumps handling flammable products as in this industry.

In spite of this I have several times found wrong bearings in this aspect in warehouses in the oil industry, see below photos. Once again, training is a must to get this type of most important information known.

BearingTip No. 9: High quality of bearing seats on shafts and in housings are a must for the reliability of the bearings.

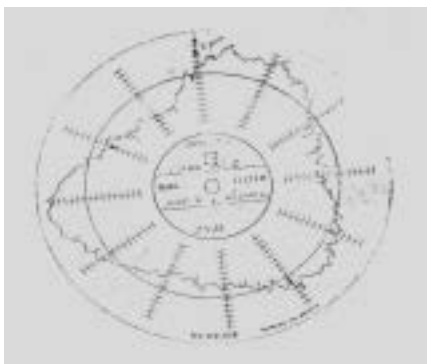
The OEMs of equipment as electric motors, pumps, gearboxes, etc. manufacture the bearing seating on their shafts and housings totally according to the quality recommended by bearing manufacturers. Thus, to achieve this they have invested in the required machines and measuring equipment to be competitive in bearing life and vibration levels.

But then, when end-users let the failures continue to total failures, these damage the seating on shafts and in the housings, that means that these must be repaired. The problem is that these repairs usually are performed by general repair shop that do not have the special machines and measuring equipment to achieve the same quality as the OEM:s and this equipment will never reach the same reliabilities as new again.

This is another of the many advantages of the predictive maintenance: To advise soon enough to avoid catastrophic failures that will cause collateral damages. I have several times got the question: “As new this motor lasted for 8 years but after the repair it only lasts for 2 years, why so?”.

A practical example: The graphics below show the form of a repaired housing for a 6205-2Z with an out of roundness of 24 microns, the form of the raceway in the outer ring and third, the form of this raceway as the ring was mounted in the housing: The same 24 microns out of roundness!

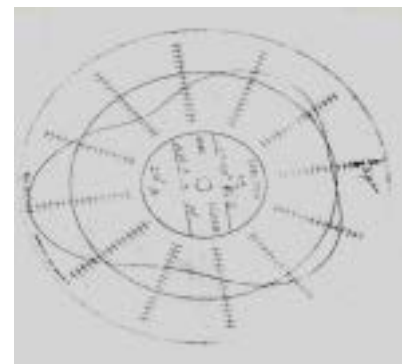
BearingTips No. 10: “Lubricators” should be true TRIBOLOGISTS!



Out of roundness of the housing 24µm



Out of roundness of the raceway of the outer ring previous to the mounting (1µm)



Out of roundness of the raceway of the outer ring previous to the mounting (24µm)

Graph by Talyrond, Resolution 2µm

An inadequate lubrication is the most common cause for bearing failures in the industry:

Bearings are as perfect as their Lubrication!

The explanation is very simple: When the lubrication fail, bearing fail! Even the highest quality bearings!

According to several statistics, an inadequate lubrication is the cause for at least 50% of bearing premature failures in the industry.

The reason for this is very simple: The lubrication is not given the importance it deserves: Lubricants are chosen based on price, not specifications, and the lubrication is performed by personnel without the required knowledge and training.

Thus, one of the biggest opportunities is to convert the “Lubricators” into true “Tribologists”, i.e. Lubrication. Specialists As such, they should perform the following activities and responsibilities:

1. Selection of the adequate lubricants and lubrication systems for each application.
2. Detailed specification (at least 5 properties) on the purchase order for each lubricant.
3. Determine and implement the correct storing and handling of the lubricants.
4. Realize the condition monitoring of the lubricants as part of the Predictive Maintenance.
5. Generate the technical and economic justifications for the lubricants and lubrication systems as for the required Corrective Actions.

Best Professional Training – But how?

- Which way is the best formula for Training?
- There are many different ways to train people, which one is the best?

Let me talk about my personnel experience. First at school, which were the classes we liked most? Those we found interesting and where we felt that we learnt important and useful things.

Those where the teachers were able to explain why and encouraged us to make questions. Those that were linked to our life and gave us practical examples. Which were the teachers we disliked? Those who did not like questions and even got irritated when we asked. Those who were unable to explain making references to the books: “Because the book say so” or just “That is the way it is”.

In my experience, the same is also most valid for our training as professionals. As Reliability Services Manager at SKF, one of our important activities were our courses for Bearing Reliability. SKF had developed several main courses which I translated to Spanish and



complemented with typical information I had found relevant and special for the Mexican industry. Then, train the trainers. They should have enough knowledge, but also the best way to communicate this knowledge.

My priority was and still is, always to assure that the participants get the answer on WHY of everything. They should always be able to explain the why of everything and definitely never have to say “The instructor told” or “the manual says”. Being able to explain the why’s they will also gain respect at their work and nobody can take away your professional pride. After retiring from SKF, after 33 years, I still try to continue in the same way and always ask for feedback, for the never-ending improvement.

The training can be made in 2 different

types of courses: **General Courses** - at a hotel for customers in general; these courses have standard subjects.

Courses on Site - with subjects selected based on the priorities and needs expressed and negotiated with the corresponding customer.

General Courses

Advantages:

- Huge interchange of experiences in between the participants.

Disadvantages:

- Not all subjects of the course may be of interest to all the participants.
- Practical exercises are not possible.

- High cost for the participants due to travelling expenses.

- Only a few participants may have difficulties for training others and to implement changes when they get back to their plants.

Courses on Site

Advantages:

- The subjects for the course are selected and agreed upon according to the priorities and needs of the corresponding customer for maximum effects.
- Practical exercises are easily performed on the field, warehouse and repair shops in the plants.
- The costs are much lower than General Courses.
- The group of participants is strong enough to implement changes and corrective actions.

Disadvantages:

- In some cases there may be difficulties to have the required quantity of participants available depending on the organization and the conditions of the corresponding plant.
- The participants are often distracted by attending problems during the course being available on site.

The above has now made that almost 80% of my courses are realized on site.

Last, but not least, it is important to evaluate the learning acquired by each and every participant at the courses. In order to do this, I perform 2 tests in writing in each course according to its subjects: One before starting the course to determine the actual knowledge, find serious misunderstandings that must be corrected during the course and to be able to focus the course on the most important opportunities within the subjects of each course. At the end of my courses, I make the same test again to determine the amount of knowledge acquired by each and every participant. The results of the tests are informed to the participants and relevant persons in the plant, as the bosses of the participants and Human Resources. Besides knowing the above, the participants in the courses take the courses more seriously putting more attention which improves the general quality of the courses.



In almost every course specific bearing problems in the corresponding plant have been discussed and solutions have been developed by the participants themselves based on the acquired knowledge to be implemented immediately after the course.

Conclusions

1. The subjects for the courses must be in accordance with the priorities and specific needs of the corresponding customer.
2. The participants must learn the why's of all the information to be able to later

explain and implement the required changes and corrective actions to improve the reliability of the bearings in the plant.
3. The acquired knowledge must be reviewed and notified.

Learn more about "Bearing Failures and Their Causes" at www.reliabilityinstitute.com or contact Per Arnold Elgqvist Olsson for all your further questions on his

email proactivo.news@gmail.com



Per Arnold Elgqvist

Mr. Per Arnold Elgqvist has 34 years of experience in SKF as Quality, Product Engineering and Reliability Services Manager. He works since 10 years as private consultant for the industry in Mexico, Venezuela, Brazil, Colombia, Peru and Argentina.

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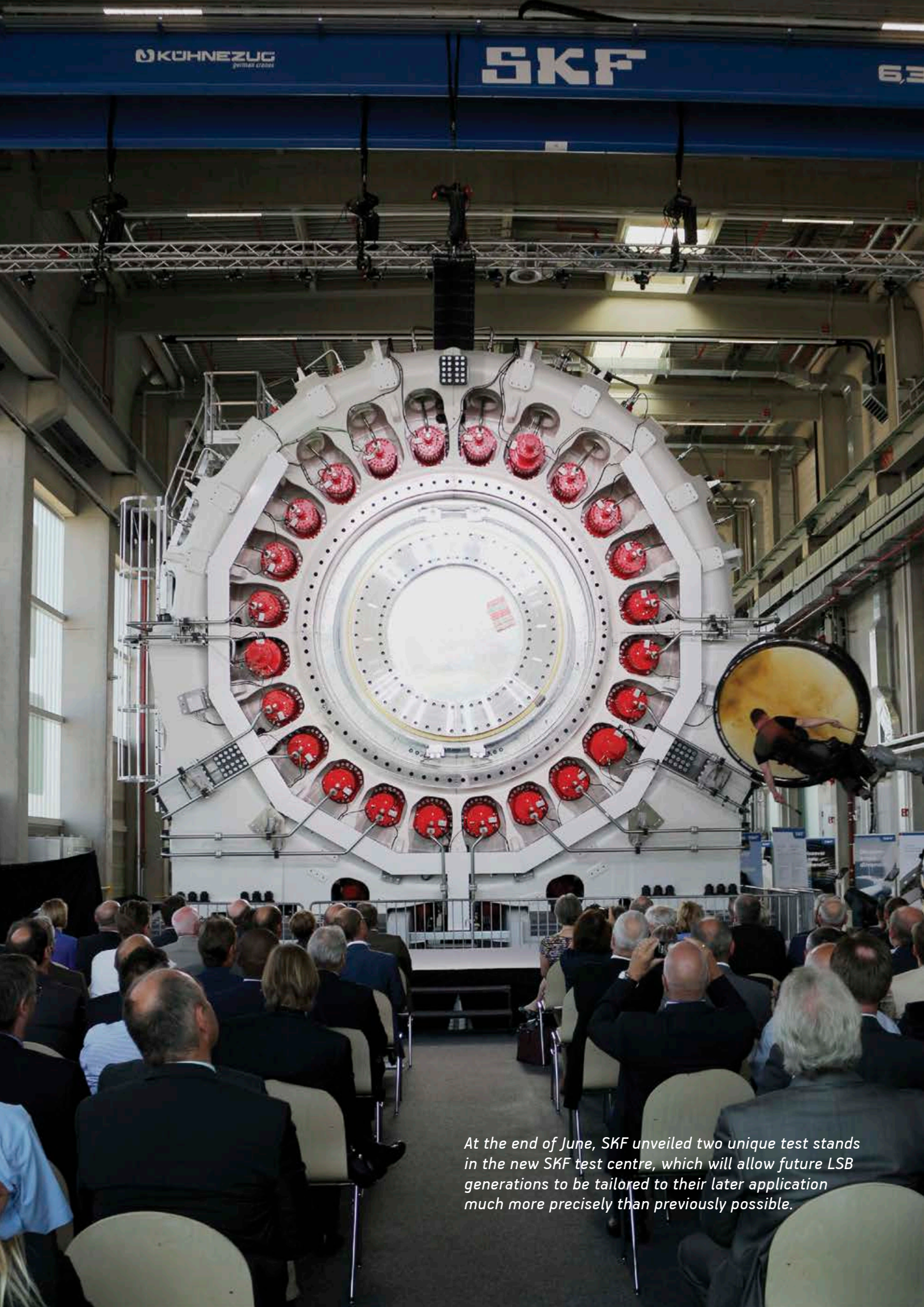


SKF's new Sven Wingquist Test Center in Schweinfurt houses the world's most powerful LSB test facilities.

AFTER 110 YEARS, BASIC RESEARCH IS STILL GOING STRONG AT THE SKF LARGE-SIZE BEARING TEST CENTRE

Just a few weeks ago, SKF has opened its “Sven Wingquist Test Center” – the world’s most powerful large-size bearing (LSB) test facility. In an interview, Martin Johannsmann, CEO of SKF GmbH explains the motives for the 40 million euro investment at the company’s Schweinfurt site and how SKF customers can profit from it.





At the end of June, SKF unveiled two unique test stands in the new SKF test centre, which will allow future LSB generations to be tailored to their later application much more precisely than previously possible.

Mr. Johannsmann, you have said that your new large-size bearing test centre has no equal anywhere in the world. What makes it so unique?

The two new test stands that we have installed in this facility amount to nothing less than technological pioneering work. They represent the continuation of our state-of-the-art test centre's innovation tradition, which our company's founding father Sven Wingquist established 110 years ago with the invention of the double-row self-aligning ball bearing: a product that remains indispensable in many industrial applications to this day. Of course, we have continually developed and innovated bearing technology since those days, but there is still further optimisation potential. It is exactly this potential that we want to tap into for the benefit of our customers, and that is why we need the new test stands.

After 110 years, the technology in this field has presumably reached a high level of maturity. What further findings do you expect to gain with the new test stands?

This is, of course, a justified question. But to understand the full implications, we must first consider the following: In the course of our company's long history, we have acquired an enormous know-how in development, design and practical applications. By now, this knowledge has been distilled into highly complex simulation programs, which we use to calculate the best possible bearing design for various applications with a fairly high level of accuracy. Simulation also allows us to accurately predict the lifespan of any bearing in any specific scenario. But bearings with unusually large dimensions continue to hold a few "secrets", if you like. In practice, unexpected problems still occur with bearing that have been meticulously

calculated and were even designed to include reserves of safety. I should stress that this is a universal issue in designing large bearings. Put another way, in real life there are phenomena that occur in LSBs that are not yet sufficiently taken into account by the cause-effect algorithms of the currently available simulation models. These phenomena are one aspect that we want to investigate with our new test stands. We are conducting fundamental research here, even if bearings of this size and of various makes have been around for a while.

And how exactly will SKF conduct this research in the Sven Wingquist Test Center?

The LSBs that will be tested on our new test stand will mostly be used in wind energy installations. The stand is the first of its kind that is capable of testing a complete bearing unit, including the customer's own components, whereas previously it was only possible to test single bearings under particularly relevant conditions. It has been sized for bearing designs that we expect to see, for example, in future turbines with an output of 10 MW and more. With a kind of "adapter", the stand can hold bearings with an outer diameter of up to six metres.

It can also apply forces in all directions to these huge bearings that, in combination, are several times higher than those of the previously most powerful test stands. The new test stand is also capable of much higher test speeds than were previously possible. In short, it allows all conceivable loads that act upon this kind of bearing in the space of 20 years to be applied much more realistically than is possible with any current simulation program – and that within just a few weeks or months.



"Thanks to the findings of our new test centre, users of future LSB generations will be able to minimise overall lifecycle costs, thereby boosting their competitiveness."

Martin Johannsmann, CEO of SKF GmbH

And what are the special characteristics of the second test stand?

Compared to the larger stand, the smaller addition to our test centre may look less impressive, but appearances can be deceiving: It is capable of running large-size bearings for applications such as ships, mining, the paper industry, the cement and the steel sector to their absolute load limits. It does this by applying forces of at least six meganewtons. To bring this into perspective: That's about as much as a single rocket engine of the Saturn V moon rocket produces. And it does this at rotational speeds of up to 200 r.p.m. It can also be used to test bearings under poor lubrication conditions. By analysing the resulting operating states, we will be able to better understand the tribological interactions between various lubrication conditions, bearing designs and materials under highly dynamic loads.

That sounds like a lot of effort. How do your customers benefit from all this?

First of all I should point out that it has environmental benefits. The findings from our tests will, of course, be used in the development and design of future generations of LSBs. From the environmental point of view, this means that we will be able to use the test results to design future LSBs such that their production requires fewer resources despite their higher robustness and durability. In addition, the new test stands allow us to run load tests on LSB prototypes more energy-efficiently; not only because of the short test durations but also because both test stands have been equipped with an energy recovery system. This is also why we have been awarded funding of about 1.9 million euros from the Bavarian Ministry of

Economic Affairs and Media, Energy and Technology for our larger “stress tester” and of about 1.6 million euros for the test stand for other heavy industry applications through the Environment innovation Programme of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety.

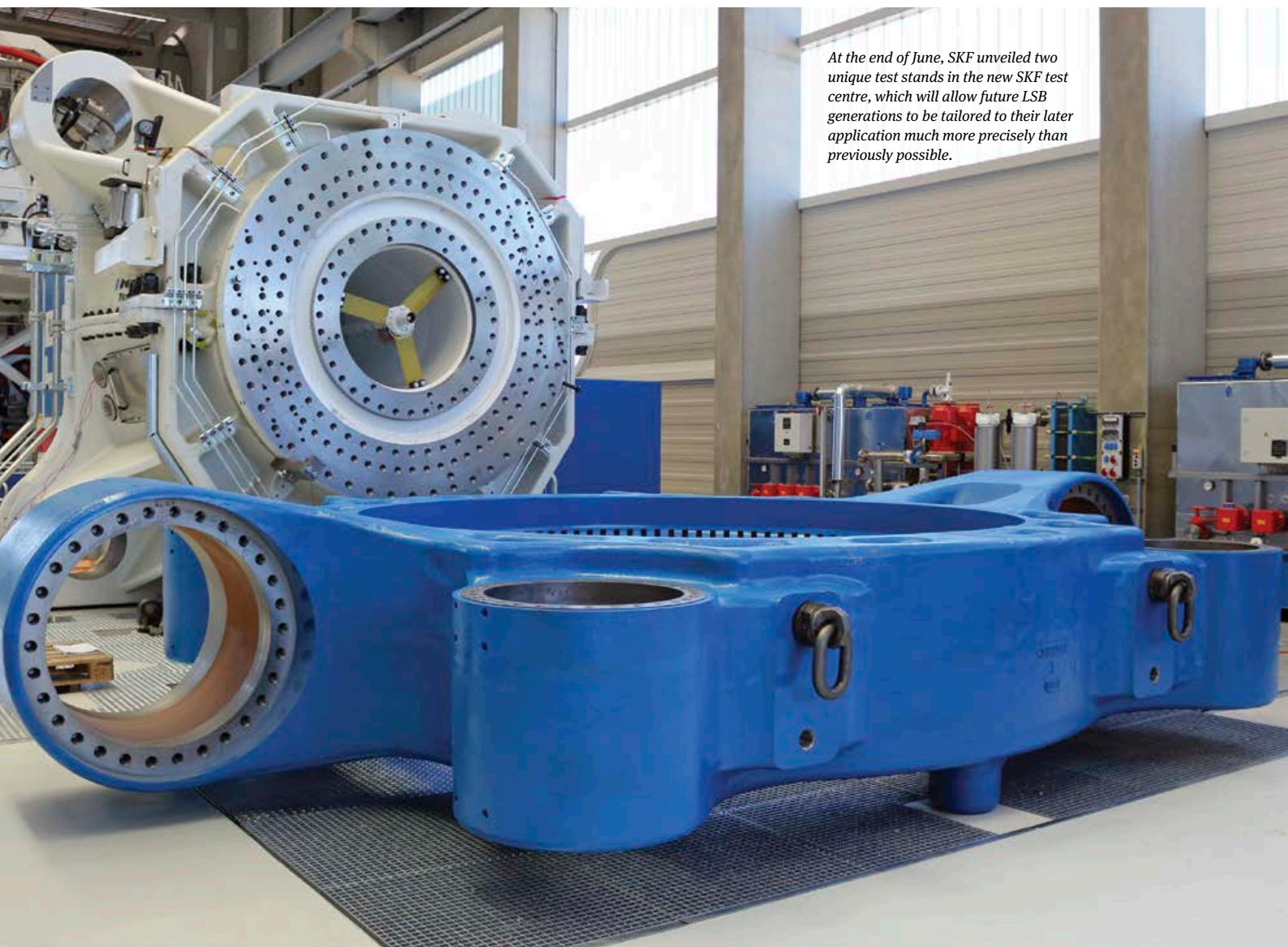
OK, understood. And the benefit for your customers?

To continue with the wind energy example: The LSBs used in wind turbines should ideally last for 20 years or more, so that the operator’s investment in the plant pays off. These bearings, then, are a key element in maximising profitability for the operator. In other words: less maintenance equals lower running costs equals high return on investment. The

same formula can, of course, be applied to other branches of industry. The test centre’s findings will help us optimise the next generation of LSBs for different sectors to maximise their durability and minimise their weight and friction in each application scenario. All in all, customers’ installations will become more efficient, regardless of their industry segment, allowing users of future LSB generations to minimise their overall life cycle costs and thereby boost their competitiveness.

Why has SKF chosen to build its new test centre in Germany? After all, your company also produces similar bearings abroad ...

That’s true, but there were several good reasons for choosing Germany: For one thing, we have been building LSBs for the wind industry in Schweinfurt



At the end of June, SKF unveiled two unique test stands in the new SKF test centre, which will allow future LSB generations to be tailored to their later application much more precisely than previously possible.

since 1990. This means that we already have the required “XXL infrastructure” here, for example the production technology, the on-site materials and large bearing transport facilities, the packaging and dispatch logistics, and so on. Other technical facilities, such as those required for overhauling used LSBs, and the metallurgical laboratory with the capabilities of meeting the special requirements of LSB engineering are also based here. All this is the result of the 120 million Euros that we had already invested in a state-of-the-art LSB production plant in Schweinfurt up until 2009.

Production is one aspect; and where does the engineering take place?

Also mainly here in Schweinfurt. The expertise gathered here plays a major role within the Group when it comes to choosing a location: Key functions such as product development and design, customer advice and application engineering for many LSB types and customers are already located here. Of course, we also foster international cooperations with developers and engineers, for example in Sweden, where the responsibility for the self-aligning roller bearings that we have already mentioned lies. You can look on the test centre as the “last piece of the puzzle” for Schweinfurt, which now completes our strategy of bundling our customer-oriented LSB expertise at this site: We now have everything here that is needed for producing LSBs. If you like, SKF has created a kind of “LSB metropolis” in this part of Germany that is unrivalled anywhere on earth.

You have mentioned that the two new test stands have been supported with German public funds. Was this a further argument in favour of the Schweinfurt site?



The new LSB test centre completes the engineering and production capabilities that SKF has concentrated at its Schweinfurt site. The findings from the new test centre will also be used to optimise the large self-aligning roller bearings (right picture) produced in Göteborg, Sweden.

Absolutely. These funds were a major factor in favour of this site. The Bavarian and federal governments have supported us with a total of about 3.5 million Euros and I am very grateful to both of these institutions

that they have enabled SKF to realise this pioneering achievement in Germany. We welcome Germany’s political aim of promoting energy-efficient future technologies in-country that have a global sales market.



**Bundesministerium
für Umwelt, Naturschutz,
Bau und Reaktorsicherheit**

Gefördert durch

Bayerisches Staatsministerium für
Wirtschaft und Medien, Energie und Technologie



Construction of the larger of the two test stands was supported by the Bavarian Ministry of Economic Affairs and Media, Energy and Technology with funding of about 1.9 million euros, while the test stand for other heavy industry applications received about 1.6 million euros through the Environment innovation Programme of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety.



Academic
Paper

Full Dynamic Ball Bearing Model with Elastic OuterRing for High Speed Applications

by Christian Wagner, Andreas Krinner, Thomas Thimmel and Daniel Rixen

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Abstract: Ball bearings are commonly used in high speed turbomachinery and have a critical influence on the rotordynamic behavior. Therefore, a simulation model of the bearing to predict the dynamic influence is essential. The presented model is a further step to develop an accurate and efficient characterization of the ball bearing's rotor dynamic parameters such as stiffness and deflections as well as vibrational excitations induced by the discrete rolling elements. To make it applicable to high speed turbomachinery, the model considers centrifugal forces, gyroscopic effects and ball spinning. The consideration of an elastic outer ring makes the bearing model suitable for integrated lightweight bearing constructions used in modern aircraft turbines. In order to include transient rotordynamic behavior, the model is built as a full dynamic multibody simulation with time integration. To investigate the influence of the elasticity of the outer ring, a comparison with a rigid formulation for several rotational speeds and loads is presented.

Keywords: ball bearing; elastic outer ring; rotordynamics; vibrations; model reduction; multibody simulation

1. Introduction

Widely used in common machinery, rolling element bearings permit a rotational motion between two components. The advantages of ball bearings like low friction and maintenance make them suitable for most applications. In contrast to journal bearings, no rotor instability occurs, which makes them perfect for high speed applications. The trend towards more powerful and lightweight turbomachinery requires precise control and prediction of rotor vibrations and dynamic behavior. A precise bearing model is essential for the following two reasons: first, it allows the calculation of typical rotordynamic coefficients like speed and load-dependent stiffness. These parameters are important for the determination of the rotor's critical speeds as well as for the definition of the operational ranges. Second, a precise bearing model provides insight into the bearings excitation frequency. For instance, under radial load, there is always an excitation in the range of the ball passing frequency due to the discrete rolling elements. A damaged bearing with faults at the raceways or the balls generates additional system excitations in frequency ranges, which can be calculated in the dynamic simulation. In high speed lightweight applications such as turbopumps or compressors, angular contact ball bearings are used. They are axially preloaded to avoid clearance. The associated ball kinematics cause, besides the centrifugal forces, gyroscopic moments and ball spinning. This causes additional loads and wear that have to be considered in machinery design. In lightweight turbomachinery, mostly for highly integrated aircraft applications, the bearing raceways are directly integrated in the shaft and the housing itself. This hinders the direct prediction of the bearing effects on the rotordynamics. To follow this aspect in this contribution, the outer bearing ring



is modeled elastically using the finite element method (FEM). This allows the determination of the interaction between the balls and the elastic structure resulting in overall shaft support stiffness.

The issue of bearing modeling has been dealt with for over 50 years. Among the first who dealt deeper with kinematic and kinetic analyzes were Jones [1] and Harris [2]. Due to the lack of computing power, no extensive dynamic simulations could be carried out, which led to a quasi-static model with many simplifications. Firstly, the geometric relationships and quantities within the bearing were outlined by Harris. Secondly, contact forces and deformations (see Figure 1) were derived based on the Hertzian-contact theory.

Using the simplification stated by the race control hypothesis, which assumes that there is no relative motion between the ball and the bearing rings surface ($\vec{\omega}_s = 0$ and $\Delta v = 0$) and the inclusion of centrifugal forces and gyroscopic moments M_g , equilibrium relationships were derived. Further simplifications are made by neglecting the ball-cage interaction and assuming identical angular distribution of the balls around the rotation axis of the bearing.

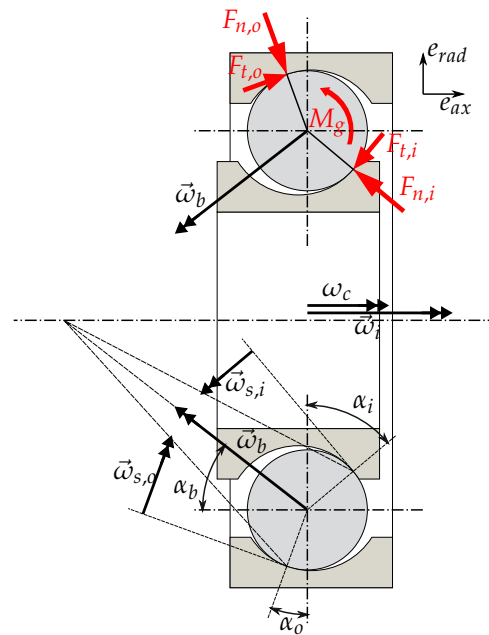


Figure 1. Ball bearing's kinetics and kinematics.

The model of Koch [3] and later Tüllmann [4] is an extension of Harris' study. The aim of this work was the investigation of increased maximum speed for axially loaded angular contact ball bearings. They extended the modeling by a degree of rotational freedom for the cage, rotating around the center of the outer ring.

To compute the angular velocity of the balls $\vec{\omega}_b$, they first determine the angle α_b by geometric relations, assuming pure rolling on both raceways. The different contact angles between the ball and the raceway (α_i and α_o) cause a relative rotational movement between the surfaces (spinning motion) $\vec{\omega}_s$. Using a friction model of the elastohydrodynamic (EHD) theory, a spinning friction loss results as a function of the ball rotating angle α_b . By minimizing the power loss, the required rotating angle is calculated. The gyroscopic moment can then be determined by the ball rotation $\vec{\omega}_b$ and the angle α_b . This is taken into account as a tangential force F_t at the contact point in the force equilibrium of the inner and outer ring (Figure 1).

Another approach to investigate the dynamic bearing behavior is made by Oest [5] and later Fritz [6]. They describe the rotational speed of the balls v_b and the cage in the assembly purely from geometrical considerations in the static, unloaded position. This is possible assuming an equal ball contact angle $\alpha_i = \alpha_o$ on the inner and the outer ring. Simplifications are also made



by neglecting the gyroscopic moments, the centrifugal forces, and the drilling friction forces of the balls. These assumptions are made under the condition of pure rolling at low operation speed.

A very detailed model for rolling bearings is the ADORE program developed by Gupta [7] over decades. It describes the behavior of the bearing through a quasi-static as well as a dynamic model. With the static model, starting solutions for the dynamic simulation are determined with assumptions similar to Koch's (no cage interaction, calculation of the ball rotation via a race control assumption under kinematic relations). The dynamic model does not require any kinematic relationships or geometric assumptions and describes both roller skidding and skewing as well as the lubricating film behavior. For this purpose, six degrees of freedom (DOF) per bearing component are used, which are coupled through the forces.

Another model is the BEAST program developed by Stacke and Fritzson [8] for the company SKF (Gothenburg, Sweden). As the model of Gupta, each bearing component has six degrees of freedom, but the contact forces between the cage and the rolling elements are described in more detail. This allows for computing additional effects numerically, such as the power loss, the lubrication film behavior as well as the forces on the cage and its behavior.

To study the bearings' vibrational behavior, Sassi [9] presents a 1D model limited to 3 DOF (both rings and one ball) to study the dynamic response of a localized defect in the bearing. Another more detailed approach is made by Tkachuk [10], who uses a 3D dynamic model with 4 DOF for each part of the bearing. They analyze the effect of axial load and misalignment on the vibration signal.

Tadina [11] uses a bearing simulation model with finite element housing to simulate the vibrational response of the bearing to different local faults, modeled as ellipsoids on the races. Modeling the raceway faults or imperfections with sinusoidal functions is proposed in [12].

To determine the effects of a varying ball number and centrifugal forces on the dynamic response and excitation of the rotor system, Vakharia [13] developed a simulation model that includes specific geometric constraint assumptions for the cage speed and the ball positions.

The description of the lubricant's behavior, the friction model as well as the EHD damping effects can require time-consuming computations. However, Wijnant [14] presents an alternative approximation method for lubricated contacts in order to gain computing efficiency and keep an acceptable level of accuracy for the EHD contact loads and damping coefficients [15]. For instance, in the frame of a rotor dynamic study, the outer ring as well as the housing and the shaft can be modeled as flexible bodies using finite element techniques including a modal reduction [14,15].

Another method consists of a multi-level model, which interpolates the solution from a set of precomputed values to provide faster results for EHD computations (see [8,16]).

The motivation for the authors' work is to develop a fast dynamic simulation model, which includes all relevant effects for high speed applications. Therefore, a minimal set of degrees of freedom, analytical and physical motivated solutions are used to avoid the most kinematic and kinetic simplifications. Besides the classic rigid bearing model, the elasticity of the outer ring is included.

The structure of this paper is as follows: in Section 2, the kinematics of the bearing components and the dominating forces are described. Section 3 outlines the modeling of the elastic outer bearing ring including a reduction of the full finite element model of the ring. The full dynamic model is summarized in Section 4 and the time integration scheme is outlined. Section 5 gives a case study of a bearing simulation and analyzes the influence of the elasticity of the outer ring on the rotordynamic coefficients and the vibrational behavior. In Section 6, conclusions are drawn.

2. Bearing Kinematics and Forces

The presented angular contact ball bearing model is based on a multibody simulation, using 6 DOF for the inner ring, 2 DOF for each ball (their axial and radial displacements) and 250 DOF for the elastic outer ring. The coordinate frames used to describe the bearing configuration are shown in Figure 2.

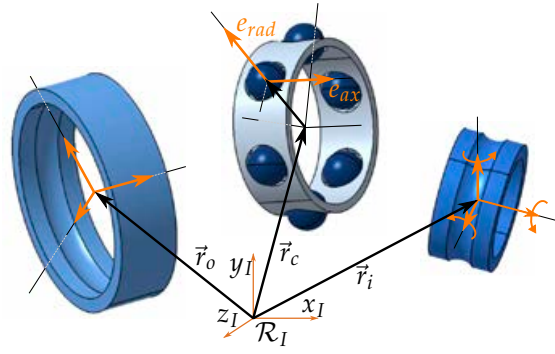


Figure 2. Degrees of freedom and coordinate systems.

The origin of the inertial coordinate system \mathcal{R}_I is fixed at the center of the outer ring, so that $\vec{r}_o = 0$. In order to describe the balls' positions, the local coordinate frame (e_{ax}, e_{rad}) is used. Each ball's local system is established according to the angle $\Phi_{b,k}$ and determined by the cage rotation $\vec{\omega}_c$.

To describe the ball-inner race and ball-outer race contacts and interactions, local coordinate frames $(\mathcal{R}_{k,i})$ and $(\mathcal{R}_{k,o})$ are used (see Figure 3). e_{ax} and e_{rad} represent the balls' degrees of freedom.

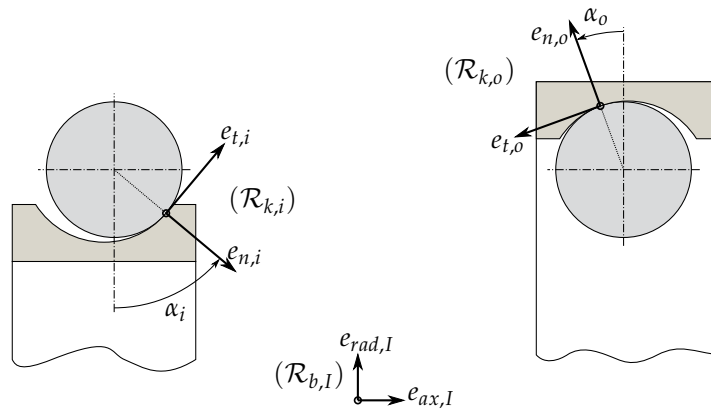


Figure 3. Local ball-race contact coordinate frames.

2.1. Deflections, Normal Forces and Cage Speed

The main step to describe the bearing behavior is to calculate the contact deflections δ_i and δ_o as well as the contact angles α_i and α_o between the ball and the inner and outer raceway (Figure 3). Therefore, a detailed description of the inner bearing geometry and geometric projections of the degrees of freedom are used. In the general bearing configuration, the contact angles are different between inner and outer ring because of the acting centrifugal forces. This is taken into account by using the 2 DOF of each ball and can be calculated with the dynamic equilibrium.

Assuming a pure rolling condition, meaning no slip in circumferential direction, the velocities of the ball centers can be calculated (see Figure 4):

$$\vec{v}_b = \frac{\vec{v}_{bo,b} + \vec{v}_{bi,b}}{2}, \quad (1)$$

and the ball rotation is given by

$$||\vec{\omega}_b|| = \frac{||v_{bo}^{cd} - v_{bi}^{cd}||}{||\vec{r}_{bo} - \vec{r}_{bi}||} \quad (2)$$

with the ball contact positions \vec{r}_{bo} and \vec{r}_{bi} , respectively, and the velocity parts in circumferential direction v_{bo}^{cd} and v_{bi}^{cd} .

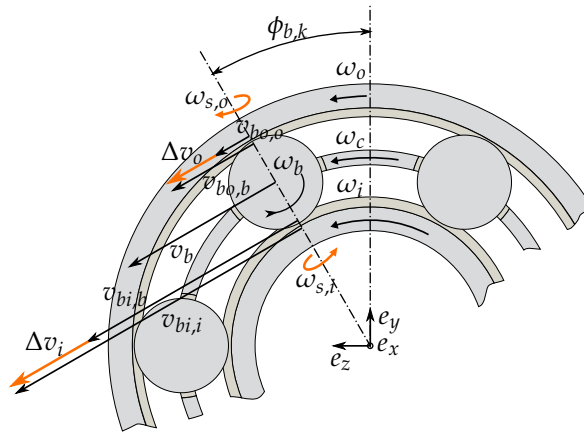


Figure 4. Velocities in the ball bearing.

Since each ball can be positioned differently in the rings, depending on the contact geometry and the ring positions, the velocity of the ball contact point can differ in addition to the velocities \vec{v}_b of the center of the balls. However, the cage constrains them all to a prescribed velocity determined by the rotational velocity $\vec{\omega}_c$ of the cage. To calculate the resulting rotational velocity $\vec{\omega}_c$, different methods exist. Here, in this contribution, a method based on a weighting approach is used and presented in the following.

The first step is to calculate the ball normal Hertzian contact forces $\vec{F}_{n,i}$ and $\vec{F}_{n,o}$ using the deflections δ_i and δ_o (see, for instance, [6]):

$$F_n = K^H \delta^{3/2}, \quad (3)$$

with the Hertzian stiffness coefficient K^H (see [5]). Note that, in this present study, the effect of lubrication is neglected. Its influence may require further investigations and could be considered, for instance, by a contact force law as derived by Wijnant [14].

The improved method to calculate the cage speed $\vec{\omega}_c$ is to take a weighted mean of the ball center velocities with the normal contact forces as weighting factors (see Figure 4):

$$\vec{\omega}_c = 1/\mathcal{F} \cdot \sum_k (||\vec{F}_{n,i}||_k + ||\vec{F}_{n,o}||_k) \frac{||\vec{c}_{b_k}^{cd}||}{||\vec{r}_{b_k} - \vec{r}_c||} \vec{e}_x, \quad (4)$$

with

$$\mathcal{F} = \sum_k (||\vec{F}_{n,i}||_k + ||\vec{F}_{n,o}||_k) \quad (5)$$

using k for the ball number. This weighting approach ensures that the velocities of balls, which are highly loaded, are taken more into account than the velocities of balls, which are not loaded. Therefore, the higher the force F_n , the more a ball is considered to satisfy the pure rolling condition. If a ball has no contact, an unloaded clearance zone occurs and no forces act on the cage. As the gyroscopic moments counterbalancing tangential forces are acting perpendicular to the cage rotation speed, they are not taken into account in this weighted averaging.

Having the cage speed $\vec{\omega}_c$, the centrifugal forces \vec{F}_c acting on the balls are calculated with the ball mass m_b and the difference of \vec{r}_b and \vec{r}_c :

$$\vec{F}_c = -m_b(\vec{\omega}_c \times (\vec{\omega}_c \times (\vec{r}_b - \vec{r}_c))). \quad (6)$$

They are acting in the direction of \vec{e}_{rad} .



2.1.1. Spinning, Skidding and Gyroscopic Moments

To calculate the gyroscopic effects of the rolling elements, the balls' rotational velocity $\vec{\omega}_b$ is needed. The ball rotation axis $\vec{\omega}_b$ cannot be normal for both contact ellipses at the outer and inner ring contacts simultaneously because of the different angles α_o and α_i . This causes relative rotation velocity at the contact points, called here spinning motion and denoted by $\vec{\omega}_{s,o}$ and $\vec{\omega}_{s,i}$ at the raceways (see Figure 4). It generates the power loss P_{loss} and wear on the surfaces due to the friction forces at the contact ellipse. The determination of the ball rotation $\vec{\omega}_b$ is not possible using only geometrical constraints.

A modern approach for this calculation of $\vec{\omega}_b$ is made by [3,4]. It is applied to every ball in this dynamic bearing model. The methodology is to minimize the ball spinning power loss P_{loss} to get the ball's rotation angle α_b . Therefore, the ball spinning motion for each contact is calculated depending on the ball rotation vector: $\vec{\omega}_s = f(\vec{\omega}_b)$. The power loss is then calculated using the spin vector $\vec{\omega}_s$ and the relative skidding velocity $\Delta\vec{v}$ to:

$$P_{loss} = \int_S ||\vec{v}(P) \cdot \tau(P)|| dS, \quad (7)$$

where $\vec{v}(P)$ is the slip velocity and $\tau(P) = p(P) \cdot \mu$ is the friction shear stress in the contact ellipse at point P , the integration taking place over the entire ellipse (see Figure 5). The chosen dry coulomb friction coefficient for steel is $\mu = 0.1$ and $p(P)$ is the local hertz pressure. The local slip velocity $\vec{v}(P)$ at point P is:

$$\vec{v}(P) = \Delta\vec{v} + \vec{\omega}_s \times \vec{O}'P. \quad (8)$$

The skidding velocity $\Delta\vec{v}$ is calculated from the cage rotation $\vec{\omega}_c$ and the contact point velocities assuming that the skidding velocity at both contact points is equal ($\Delta\vec{v} = \Delta\vec{v}_o = \Delta\vec{v}_i$), so:

$$\Delta\vec{v} = \vec{v}_b - \vec{\omega}_c \times (\vec{r}_b - \vec{r}_c). \quad (9)$$

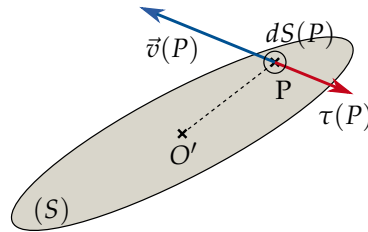


Figure 5. Power loss, velocity and pressure in the contact ellipse.

The calculated power loss is then added for both contacts for each ball and is a function of the ball rotation vector $P_{loss} = f(\vec{\omega}_b)$ and its angle α_b and magnitude. A numerical minimization of the power loss leads to $\vec{\omega}_b$ and must be performed in each timestep. The reached power loss and the spinning motion are a part of the whole bearing losses and can be used for frictional, thermal or wear calculations.

The gyroscopic moments caused by the misalignment between the balls' rotation $\vec{\omega}_b$ and the bearing axis are shown in Figure 1. It is defined with the balls' moment of inertia J_b as:

$$\vec{M}_g = J_b \vec{\omega}_b \times \vec{\omega}_c. \quad (10)$$

We assume that these gyroscopic moments are in equilibrium with the moments created on the ball by the tangential forces \vec{F}_t (Figure 1), acting at the ball-race contact points.



2.1.2. Damping in Ball Race Contact

In our dry bearing case, there is only little damping compared to the lubricated one, where the elastohydrodynamic oil film generates the damping forces. However, the cyclic deformation of a linear-elastic material causes energy losses that correspond to the hysteresis on a load-displacement diagram. For a specific material, the loss factor Ψ_d corresponds to the dissipated energy E_D and the strain energy E_S over a deformation cycle (see [5]):

$$\Psi_d = \frac{E_D}{2\pi E_S}. \quad (11)$$

For this model, $\Psi_d = 1.5\%$ is chosen for each bearing contact. To propose a viscous damping coefficient c , the energy dissipation is compared for a 1D oscillator system. The resulting coefficient c is a function of Ψ_d , the Hertzian contact stiffness k_h and the deformation frequency $\omega_{bp} = ||\vec{\omega}_c||/n_k$, the ball passing frequency (n_k is the number of balls), to [5]:

$$c = \Psi_d \frac{k_h}{\omega_{bp}}. \quad (12)$$

3. Modeling of the Elastic Outer Ring

So far, the local penetration between ball and outer raceway is taken into account due to the Hertzian contact model (see Section 2.1). In order to cover the global deflection of the outer raceway in addition to the local one, an elastic model for the bearing outer ring is considered. The inner ring elasticity can also be modeled. As an example, only the elasticity of the outer ring is considered. In this work, it is represented by a reduced finite element model with linear elastic material behavior.

The following steps describe representatively the process of the outer ring modeling. First, the physical dimensions define the geometry of the elastic ring. Second, a discretization by the finite element method gives the governing equations for the full outer ring model. In the last step, an adequate reduction method decreases the size of the full model for a later efficient consideration in the dynamic simulation. Here, the Craig–Bampton approach is applied.

3.1. Geometry

The geometry of the bearing outer ring is defined by the physical dimensions of the rigid bearing. As an example, without loss of generality, the outer ring is approximated in the following by a cuboid of dimensions $D_o \times D_o \times W_o$ with the side length D_o and the width W_o of the outer ring. The cuboid has a hollow cylinder with diameter d_o representing the outer raceway inside the bearing ring. Despite the simple FE geometry, the detailed geometric curvature of the outer raceway is still considered by an analytical superposition. Thus, it is possible to choose a very crude or highly reduced FE mesh and to represent a real bearing raceway geometry (represented by the curvature radii and its centers) for calculating the deflections and contact forces.

3.2. Finite Element Approach

In the next step, a finite element approach is used in order to discretize the structural equations of the bearing ring. This step is performed in a finite element software tool. The elastic volume is discretized by using three-dimensional incomplete quadrilateral elements (each with 20 nodes) with serendipity shape functions. A structured mesh is applied to the interface of the hollow cylinder by using 40 elements in circumferential and four elements in axial directions, respectively. Bi-quadratic finite elements (each with eight nodes) are used for the interface. The degrees of freedom of the nodes



of the cuboid's bottom are fixed. Figure 6 shows the finite element model of the bearing outer ring structure. The homogeneous space-discretized equation of the full finite element model is stated as

$$M_{FE} \ddot{\vec{x}} + K_{FE} \vec{x} = \vec{0}, \quad (13)$$

with the finite element mass matrix M_{FE} and the finite element stiffness matrix K_{FE} . The vector \vec{x} represents the N elastic coordinates of the full ring model.

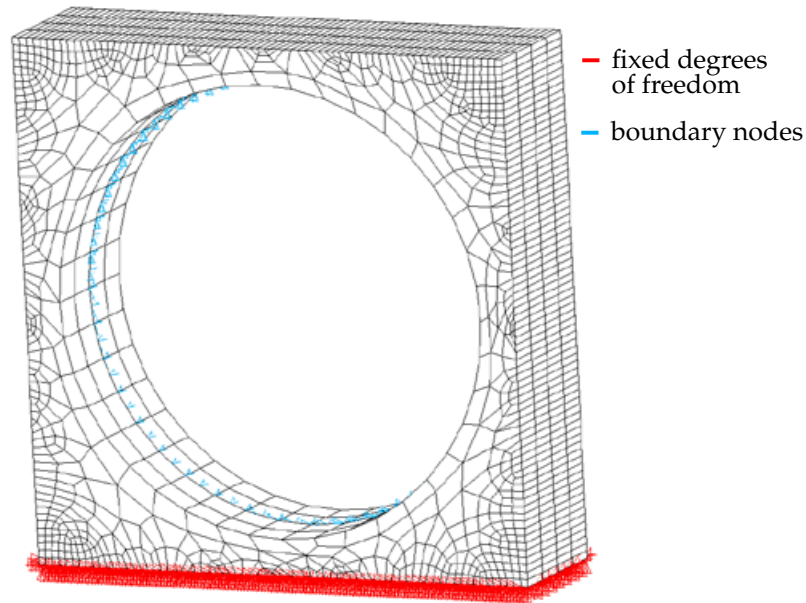


Figure 6. Finite element model of an elastic bearing outer ring.

3.3. Reduction Methodology

Due to the large number of elastic degrees of freedom, the full finite element model can hardly be handled in a dynamic multibody simulation. Therefore, in the following, the full model with its N degrees of freedom is reduced by the classical Craig–Bampton method.

For the Craig–Bampton reduction, the vector \vec{x} of the full model is decomposed into a vector \vec{x}_b containing n_b displacements of boundary nodes and a vector \vec{x}_i containing n_i displacements of inner nodes. The degrees of freedom are thus partitioned as $\vec{x} = \begin{pmatrix} \vec{x}_b^T & \vec{x}_i^T \end{pmatrix}^T$ with the total number of nodes $N = n_b + n_i$. As the boundary nodes are later retained for the reduced model, they are chosen as the nodes that belong to the circle of the outer raceway, indicated in blue in Figure 6. The residual nodes correspond to the inner nodes of the model. Then, a reduction $\vec{x} = T \vec{q}_{el}$ by the Craig–Bampton approach is defined as:

$$\vec{x} = \begin{bmatrix} I & 0 \\ -K_{ii}^{-1}K_{ib} & \Phi_v \end{bmatrix} \begin{pmatrix} \vec{x}_b \\ \vec{\eta} \end{pmatrix} = T \vec{q}_{el}. \quad (14)$$

The first columns of the reduction basis T are n_b interface constraint modes based on unit displacements of the boundary coordinates \vec{x}_i . The remaining columns contained in the matrix Φ_v a set of $n_v \ll n_i$ fixed interface normal modes. They are determined by restraining all boundary nodes and solving the obtained eigenvalue problem for the first n_v eigenvalues. Using the reduction of Equation (14), the following reduced mass and stiffness matrices are obtained:

$$M_{el} = T^T M_{FE} T, \quad K_{el} = T^T K_{FE} T. \quad (15)$$



In the later example, 80 boundary nodes and hence $n_b = 3 \times 80$ constraint modes and $n_v = 10$ vibration modes are used.

It is noteworthy that other approaches could also be used for the reduction of the full outer ring structure model. For instance, the already reduced model could be further reduced by a modal truncation approach, as followed by Novotny [17] for elastic journal bearings. In addition, a load dependent approach by using free interface normal modes and attachment modes could have been followed (see [18–20]).

4. Full Dynamic Bearing Model

The bearing assembly can be seen as two different parts: The bearing elements (the balls, cage and inner ring) and the elastic outer ring structure. The movements of the bearing elements lead to a multibody simulation, in which the elastic outer ring is a structural dynamics element.

The two parts are coupled using projections of the displacements and forces with interpolations to the constraint modes. This is discussed in detail next.

4.1. Multibody Simulation

Modeling the bearing components, the kinematics and kinetics lead to a dynamic equilibrium for each bearing component. For the inner ring, the dynamic equation writes:

$$m_i \ddot{\vec{r}}_i = - \sum_k (\vec{F}_{n,i} + \vec{F}_{t,i})_k + \vec{h}_i, \quad (16)$$

where \vec{h}_i is the vector of external forces on the inner ring. For the dynamic equation of motion of each ball k follows, using $\vec{r}_k = (e_{ax} \ e_{rad})^T$:

$$m_k \ddot{\vec{r}}_k = A_k (\vec{F}_{n,i} + \vec{F}_{t,i})_k + A_k (\vec{F}_{n,o} + \vec{F}_{t,o})_k + \vec{h}_k, \quad (17)$$

where the matrix A_k transforms the ball forces into the local ball coordinate system. The centrifugal forces are summarized in the vector \vec{h}_k . The outer ring follows with $\vec{r}_o = \vec{x}$, and the equation:

$$M_{el} \ddot{\vec{r}}_o = - \sum_k J_k^T (\vec{F}_{n,o} + \vec{F}_{t,o})_k - K_{el} \vec{r}_o, \quad (18)$$

where the Jacobi matrix J_k^T projects the k -th ball forces into the direction of the coordinates of the finite element model of the outer ring.

These three equations are summarized to a set of dynamic equations of motion of the whole bearing. A time integration scheme (MATLAB ode15s, R2016b, 7 September 2016, The MathWorks Inc., Natick, MA, USA) applied to the state space formulation of the system is used in order to get the component velocities and displacements over time.

4.2. Deflection Calculation

The contact deflection δ_i and δ_o of each ball on the inner and outer raceway, respectively, is calculated from the current state variables. The deflection $\delta_{i,k}$ depends on the coordinate vector \vec{r}_i of the inner raceway and the coordinate vector \vec{r}_k of the k -th ball. The deflection $\delta_{o,k}$ depends on the coordinate vector \vec{r}_k of the k -th ball and the current elastic deformation of the bearing housing at the ball angle $\Phi_{b,k}$ (Figure 4), which is in the following denoted by $\vec{d}_{o,k}$. The latter deformation $\vec{d}_{o,k}$ is interpolated from the deformation of the neighboring nodes by using the bi-quadratic shape functions used for the finite element discretization.

4.3. Force Projections

The ball forces $\vec{F}_{n,i}$, $\vec{F}_{t,i}$ and $\vec{F}_{n,o}$, $\vec{F}_{t,o}$ on the inner and outer raceway, respectively, are calculated on the basis of the local deflections (see Equation (3)). While they can be directly applied to the dynamic



equations of the inner ring (see Equation (16)), they have to be transformed into the local coordinate system by a matrix A_k , when applying them to the dynamic equation of the k -th ball (see Equation (18)). At the outer raceway, they have to be projected onto the elastic coordinates at the ball angle $\Phi_{b,k}$ (Figure 4). Therefore, the Jacobi matrix J_k^T is used (see Equation (18)). It contains the bi-quadratic shape functions used for the finite element discretization and evaluated at the current position $\Phi_{b,k}$.

4.4. Bearing Model Implementation

The coupling of the two parts is done directly by projecting the elastic housing's deformation to the contact deflections of the outer raceway. The normal and tangential forces are then projected back from the raceway to the housing. In this way, it is possible to add the state space formulation of the housing directly to the bearing state vector. Thus, the overall dynamic equilibrium is solved for each timestep.

Outer Ring Structural Damping

To add damping to the elastic housing, two approaches are combined. The elastic housing modes are damped by 1% modal damping ϵ using the modal expansion to build the viscous damping matrix C_{el} (see [21]):

$$C_{modal} = \sum_{s=1}^n M_{el} \vec{x}_{(s)} \frac{2\epsilon\omega_{0s}}{\mu_s} \vec{x}_{(s)}^T M_{el}, \quad (19)$$

with $\mu_s = \vec{x}_{(s)} M_{el} \vec{x}_{(s)}^T$ for the generalized mass of the state space mode $\vec{x}_{(s)}$. M_{el} is the mass matrix of the elastic housing with stiffness matrix K_{el} .

The static degrees of freedom of the housing (viscous damping matrix C_{static}) are damped using the Rayleigh approach:

$$C_{static} = \alpha M_{static} + \beta K_{static}, \quad (20)$$

with $\alpha = \beta = 1\%$. The whole damping matrix C_{el} is then assembled:

$$C_{el} = \begin{bmatrix} C_{static} & 0 \\ 0 & C_{modal} \end{bmatrix}. \quad (21)$$

To speed up the time integration scheme and to choose realistic initial conditions, the static equilibrium is solved beforehand.

5. Results of Representative Example

Showing the differences in the bearing behavior between a rigid and elastic outer ring formulation is the task of this chapter.

The examined ball bearing is a standard deep groove ball bearing of type 6404. Its outer diameter is 72 mm, the inner is 20 mm, and it includes six balls with a diameter of 15.1 mm. The material is steel and no lubrication is used. In the elastic housing case, the outer ring is replaced by the flexible structure. For a realistic rotor case simulation, some shaft mass (1 kg) and stiffness are added to the bearing's inner ring, which leads to neglecting the rotation of the inner ring system around e_y and e_z .

The results should not necessarily represent a realistic bearing. Instead, they are presented to show the differences of the model methodology and the advantage of detailed elastic formulations.

Figure 7 shows a snapshot of the dynamic simulation (time-dependent) of the bearing. It is loaded by a constant radial force of 1000 N in a positive y -direction (upwards in the figure). The shaft rotates at 1047 rpm. The green points represent the position of the elastic housing. It can be seen that the balls have a Hertzian deflection δ additionally to the housing's deformation. The deflections and deformations are amplified for better visualization. In contrast to a homogeneous black box formulation, the inhomogeneous load distribution can be seen clearly.

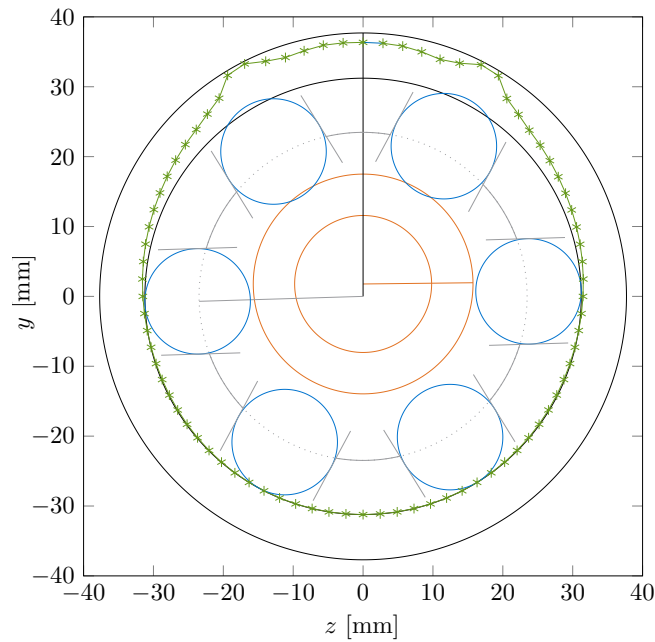


Figure 7. Visualized bearing displacements with elastic outer ring.

5.1. Bearing Displacements

The radial inner ring displacements (shaft movement) are shown in Figure 8. The bearing is loaded with radial force, in the y -direction, at several rotational speeds (3000, 6000, 12,000, 24,000 rpm) for a rigid and elastic housing formulation.

Within the rigid configurations, the speed dependency is only minor. The centrifugal forces are small with regard to the Hertzian stiffness. In the elastic housing case, a larger influence of the rotational speed can be seen. The higher the shaft speed, the higher the radial displacement.

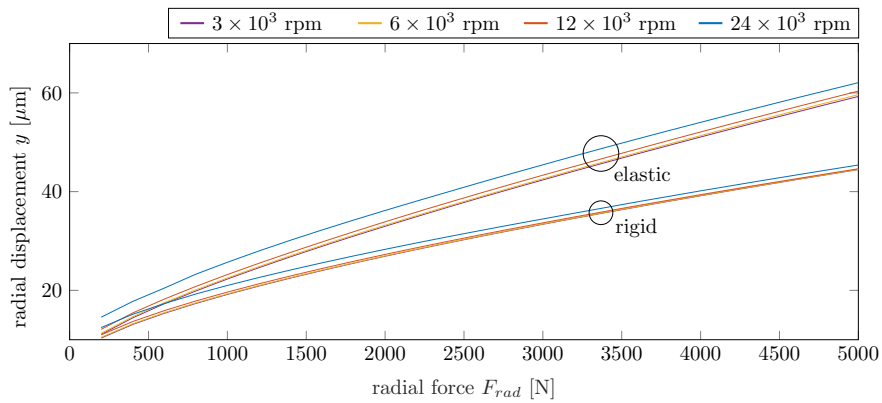


Figure 8. Inner ring displacement according to radial force at different rotational speeds.

The absolute inner ring displacement of the elastic formulation is higher compared to the rigid one. This shows the weakening effect of a soft outer ring structure. Figure 9 shows the radial bearing stiffness calculated from the displacements.

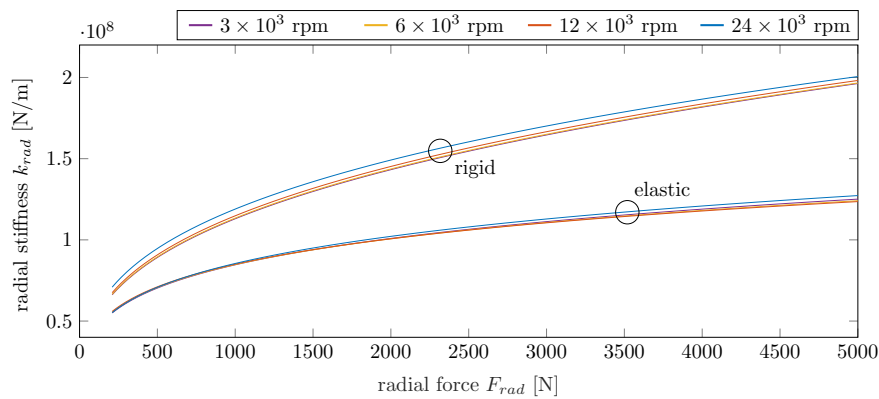


Figure 9. Radial bearing stiffness according to radial force at different rotational speeds.

5.2. Bearing Excitation Frequencies

The consideration of the bearing as an inhomogeneous, discrete parted element leads to a rotating angle-dependent behavior. Depicted in Figure 10 is the orbit plot of the inner ring motion of the constant radial loaded bearing ($F_{rad} = 1000$ N) at a constant rotational speed of 1000 rpm.

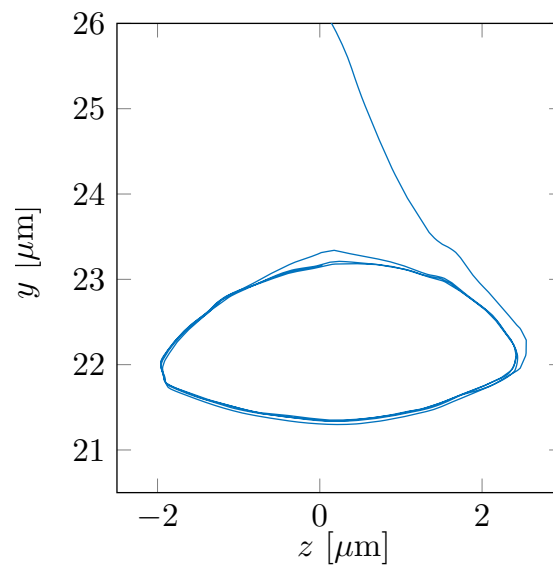


Figure 10. Inner ring orbit over time at constant radial load and rotational speed.

It indicates a movement of the shaft in an elliptic orbit. The center location is not constant unlike the load, so the dynamic simulation is useful to predict the amplitudes. The frequency of this orbit is described mainly by the ball passing frequency (see Figure 11). It has to be considered to avoid a rotor resonance at that frequency. In this case, the inner ring rotates at 1000 rpm, corresponding to 16.7 Hz.

The dominating excitation frequency is about 33.9 Hz. It excites higher frequencies of the elements and the housing. The ball passing frequency is determined by the cage speed $\vec{\omega}_c$ and the number of balls. An accurate calculation, presented in this paper, is useful for the machinery design process.

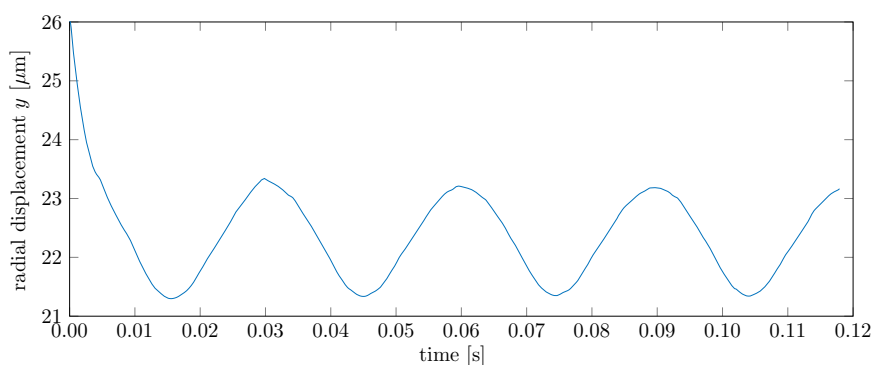


Figure 11. Inner ring displacement over time at constant radial load and rotational speed.

6. Conclusions

In this paper, a full dynamic multibody bearing simulation including an elastic outer ring is presented. The discrete elements of the bearing, the inner ring, the balls and the cage are described. To calculate the acting forces, the Hertzian theory and deflections between the bearing elements are used. To model a bearing integrated into a lightweight structure, the bearing outer ring is modeled as an elastic structure using the FEM approach and reduction techniques. Projections of forces and displacements are used to couple the multibody simulation to the structural part. This formulation makes it possible to examine the ball–structure interaction and the whole dynamic bearing behavior. A time integration leads to the shaft and bearing elements dynamic motion. To compare the elastic and the rigid outer ring approach, some stiffness and displacement results are shown. The orbit movement can lead to a vibrational excitation of the rotor. The excitation frequency is calculated using a detailed physically motivated bearing cage approach. The model still contains simplifications like the assumption of constant radii for inner and outer raceway shapes, the neglect of cage inertia and clearance effects, the simplified FE geometry or the absence of lubrication. These simplifications give space for future investigations; for instance, the validation of the model by experimental data could provide deeper knowledge on the underlying effects.

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Author Contributions: Christian Wagner and Andreas Krinner built up the simulation model. Christian Wagner analyzed the results and wrote the main part of the paper. Andreas Krinner wrote the section of the elastic formulation. Thomas Thümmel and Daniel Rixen added useful information and discussions relevant to this study.

Conflicts of Interest: The authors declare no conflict of interest.

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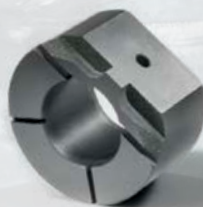
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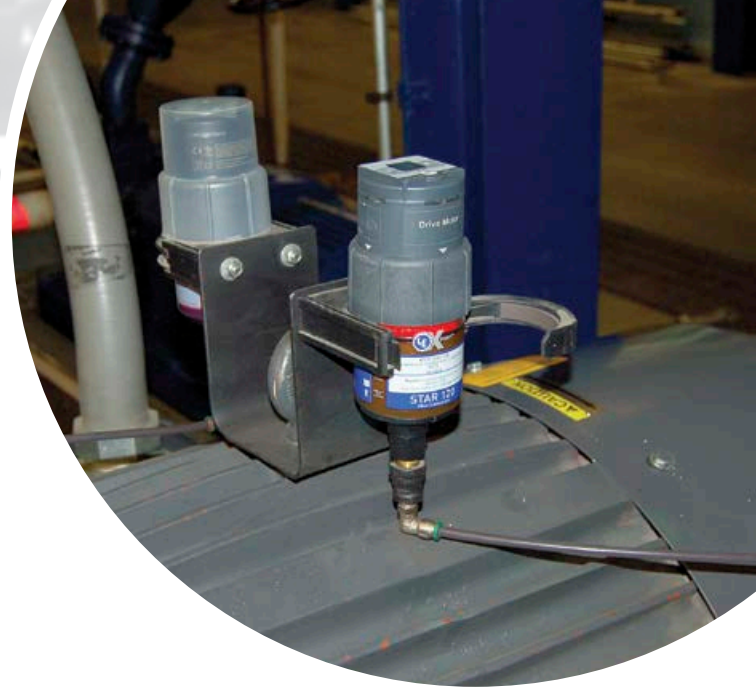
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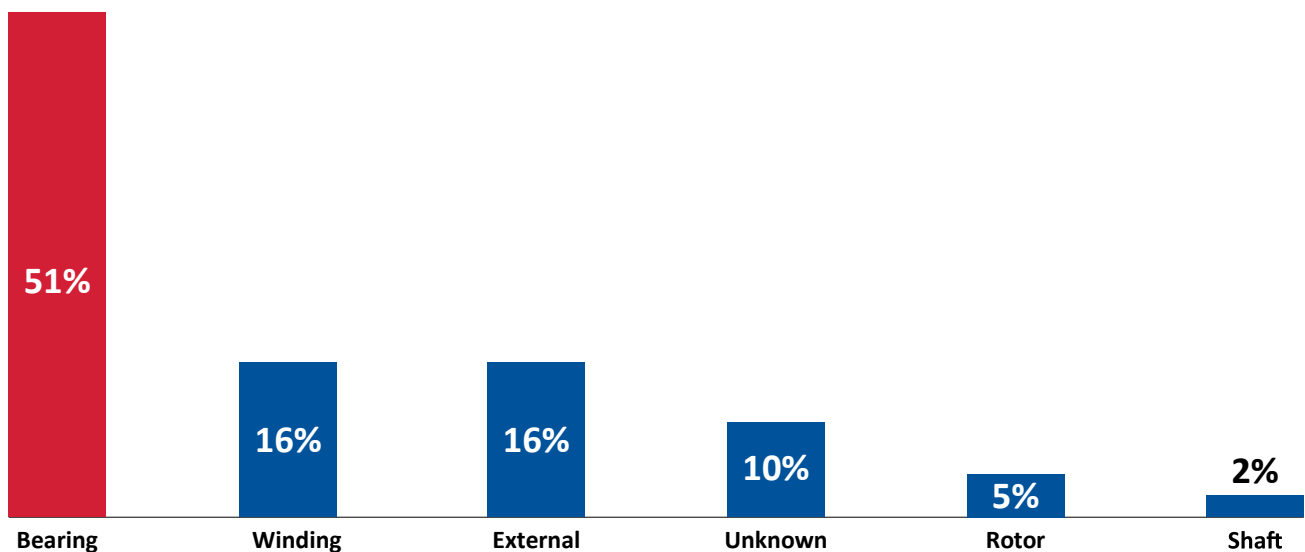
Are you getting the most out of your electric motors? Motor life depends on bearing life, and bearing life depends on proper lubrication. According to Noria Corporation, approximately 50-75 percent of electric motor failures are bearing related, and an estimated 95 percent of those failures are premature, with the bearings never reaching their intended life. According to the U.S. Department of Energy, more than 70 percent of electricity consumed in industry comes from the use of electric motors, which make up 25 percent of all rotating equipment in a plant. This means that electric motors account for nearly 25 percent of the national consumption of electricity.

What all of this means to you is that maximizing your lubrication reliability efforts with electric motors can have a dramatic impact on your uptime and costs, including repairs and replacements, labor, and energy use.

Lubrication Engineers has the lubricants, reliability products and expertise to help you put together a complete program to help maximize electric motor bearing life, minimize lubrication problems, and increase safety levels.

Root Causes of Electric Motor Failures

Courtesy of Noria Corporation



Components of an Effective Electric Motor Lubrication Program



Grease Selection



Application Method

Identify the suffering points

Move forward with proven solutions for extending equipment life



Incorrect Grease Selection

Selecting the right grease for electric motor applications can make all the difference in the protection and performance of bearings. Electric motors require lubricants with specific characteristics. Use of the wrong grease often leads to early electric motor failures.



LE Solution: The grease consistency preferred for electric motors is normally NLGI 2 or 3, with a base oil viscosity of 100-150 cSt @ 40°C. Other characteristics to look for include good channeling characteristics, low oil bleed, oxidation resistance, anti-wear additives, and mechanical stability. A polyurea thickener system is preferred for most electric motor applications, but grease with an aluminum complex, lithium complex or calcium sulfonate thickener are also good options.



Incorrect Grease Application

Common problems include overgreasing, undergreasing, and not greasing at all – all of which can lead to premature electric motor failures. Additionally, operators often have to manually grease in hard-to-reach or unsafe areas.



LE Solution: Your LE consultant can help determine correct lubrication amounts and intervals, and then help you choose which single-point lubricator will work best in your application. These precision lubrication tools provide a closed loop system to keep out contaminants, and they take the guesswork out of maintenance by supplying the right amount of grease for the application at the right time 24/7. Suitable for indoor and outdoor applications, SPLs decrease motor failures, reduce labor time and improve safety.



Grease Cross-Contamination

It is fairly common for a busy operator to pick up a grease gun and apply the wrong grease to the electric motor. When incompatible greases are mixed, the results can be catastrophic with severe loss of grease performance leading to bearing failure.



LE Solution: If manual lubrication is preferred, clear grease guns are the solution for enabling the operator to see the grease before putting it in the application. When combined with a color identification and tagging system, clear grease guns are part of a visual chain of custody for the maintenance operator – significantly reducing human error.



LE Enhanced Lubricants



Xport Lubricant Application



Xport Clear Grease Guns



Xport Single Point Lubricators

Xpel Lubricant Identification



Xpel Lubricant ID Tags



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LE's state-of-the-art manufacturing facility, technology center, warehouse and primary office is located in Wichita, KS, with regional distribution out of Knoxville, TN, and Las Vegas, NV. Additional support functions are located in Fort Worth, TX. The company's international presence includes distributors in more than 60 countries.



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- ✓ Single- and multi-point automatic grease lubricators and lubricating systems
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- ✓ Local, factory-trained specialist available 24/7



Lubrication Engineers, Inc. is the total solutions provider for lubrication reliability. We work closely with our customers to learn about their specific equipment and lubrication needs, and then help them create a world class lubrication reliability program that provides equipment protection and enhanced profits.

We start with an onsite equipment assessment. A trained, local lubrication consultant provides a detailed report recommending lubricants, application methods, usage amounts, and drain or lube intervals.

LE's line of high-performance lubricants – manufactured in the U.S. and made of highly refined base oils and proprietary additives – far exceed the performance of conventional lubricants in a wide variety of industrial and automotive applications. In addition, your LE consultant can offer you several other best practice products and services to ensure the effectiveness of your program, including solutions for oil analysis, storage, handling and transfer, contamination exclusion, contamination removal, education and training.



MAINTENANCE FREE BEARING TECHNOLOGY FROM

IKO

C-Lube technology keeps linear and rotational motion components lubricated—so you don't have to!

Walk through any plant that uses bearings or linear motion systems, and you can often see maintenance workers, grease gun in hand, applying lubrication to bearings, cam followers or linear guides. And why shouldn't they. Under-lubricated bearings can wear excessively, which leads to performance problems and premature failure.

These labor-intensive lubrication practices, however, do not come cheap. We estimate that manual lubrication can cost upwards of €500 per grease fitting when you consider the cost of the lubricant itself and the cost of the guy with the grease gun. And that figure doesn't begin to capture the total cost of manual lubrication when you consider that many grease fittings are difficult to access and service without triggering some downtime.

It doesn't have to be that way. There are a number of bearings and linear

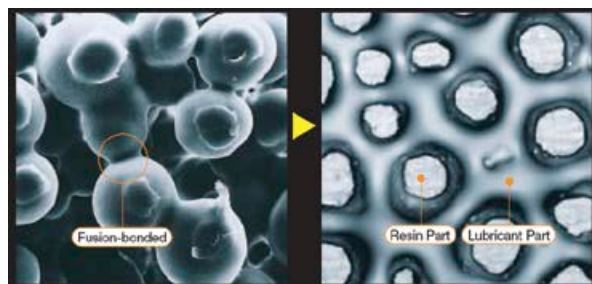
guides that offer at least some freedom from lubrication routines. You will hear them described as "lubed for life" or "maintenance free" or "self-lubricating."

These reduced maintenance bearings typically have mechanical designs with provisions for storing and delivering lubricant over long periods of time. To varying degrees, they can drastically reduce or even eliminate the need to apply lubricant beyond what is present when the bearing goes into service.

Unlike automated lubrication systems, which can be complex and costly, maintenance free bearings tend to rely on simple, integrated mechanical features in the bearing or bearing slider to store and deliver the-lubrication. This ensures a long-time reliable operation, while using a minimum of lubricant.

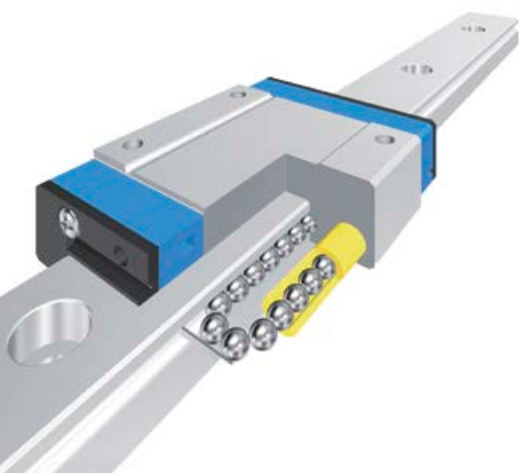
Various takes on maintenance free rotational bearings and linear guides have been around for years now, but not all of them are created equal. Some focus on achieving the longest possible maintenance free intervals. Others focus on a compact design that adds as little as possible to the size of the bearing's mechanical package.

IKO's C-Lube linear components have unique designs that balance long service life with compact size. These long-term maintenance free linear motion products come in different forms—including roller guides, ball guides and a ball-spline-based shaft guiding system. They range in size from small, 3mm-wide track rails to 65mm-wide guides that offer a basic static load rating of 768,000 N.



— Figure 1

Despite the outward differences in these products, they all make use of IKO's proprietary C-Lube lubricating elements. Made from sintered resin powder with a steel backing, these C-Lube elements have an open porous structure that can be impregnated with large amounts of oil (see Figure 1). Depending on the type of linear guide, the C-Lube elements are formed into either a plate or sleeve shape and integrated into the bearing's slider. They then release the impregnated oil





“C-Lube linear guides provide maintenance free operation for minimum 20.000 km.”

slowly through direct, continual contact with the linear guide’s internal rolling elements.

Thanks to this on-going lubrication, C-Lube linear guides provide maintenance free operation for minimum 20.000 km. In practice, that maintenance free term often equates to the entire application life.

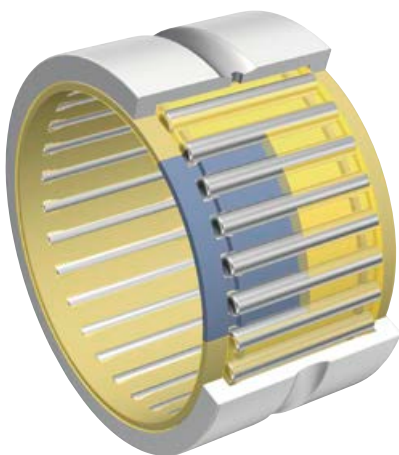
While the geometry of the lubricating element differs depending on the type of guide, in no case does C-Lube increase the overall dimensions of the guide. In other words, self-lubrication capabilities, at least for IKO products, do not increase the package size of the guide.

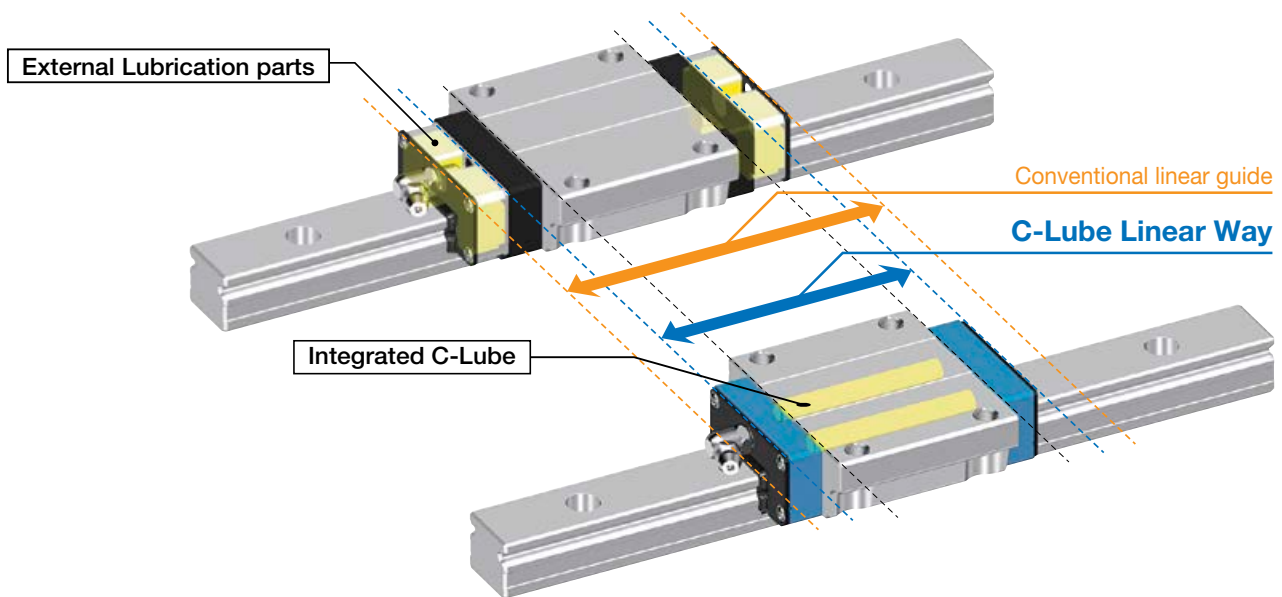
Because all the C-Lube guides offer the same maintenance free interval, the choice between them comes down to functional requirements such as the type of load and duty cycle. With that in mind, here’s an overview of the different C-Lube variants:

slider’s end plates.

- **Ball Guides** - Familiar ball guides, which run on recirculating steel balls, take on a new twist when combined with C-Lube technology. In C-Lube Linear Ways, the steel balls roll through a sleeve made from the C-Lube material. As the balls travel through the sleeve, they pick up oil themselves and also transfer it to the rail as they come in contact with it. At all times, the balls and rail remain free from any metal-on-metal contact due to a film of lubricant provided by the C-Lube feature.
- **Ball-Spline Guides** - C-Lube Ball Spline MAG guides incorporate an internal oil-impregnated plate-shaped element. As the balls traverse over the C-Lube plate, they pick up oil which lubricates both the balls and the spline shaft—again protecting against metal-on-metal contact.

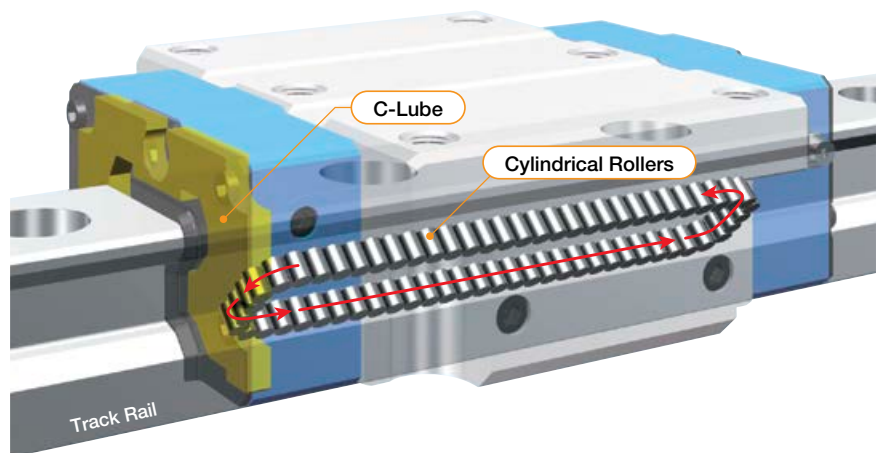
- **Roller Guides** - Designed for applications requiring maximum stiffness and resistance to moment loads, the Linear Roller Way Super MX guides feature a slider that operates on a balanced set of four cylindrical roller rows. In roller guides, the C-Lube element has been fashioned into a plate-shaped element, housed just behind the



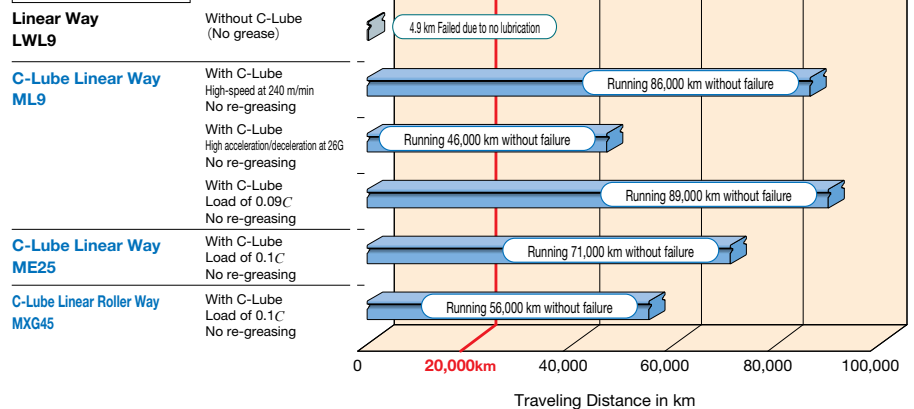


For rotational movement, IKO offers the following maintenance free series:

- Needle Roller Bearings - C-Lube**
Machined Type Needle Roller Bearing are lubricated with a newly developed thermosetting solid-type lubricant. A large amount of lubricating oil and fine particles of ultra-high molecular weight polyolefin resin are solidified by heat treatment to fill the inner space of the bearing. As the bearing rotates, the lubricating oil is applied to the raceway in proper quantities, maintaining the lubrication performance for a long period of time.
- Cam Followers - Maintenance free cam- and roller followers with thermoset solid lubricant C-Lube pre-packed in the bearing space.** As the bearing rotates, the lubricant will be applied on the needles and running surface in just the right amount to ensure a long maintenance free performance.



Durability Test Results



For the cam follower series, IKO has an additional option to mount their external C-Lube unit, which then also automatically lubricates the running outside surface, making it a maintenance free solution, both internally and externally.



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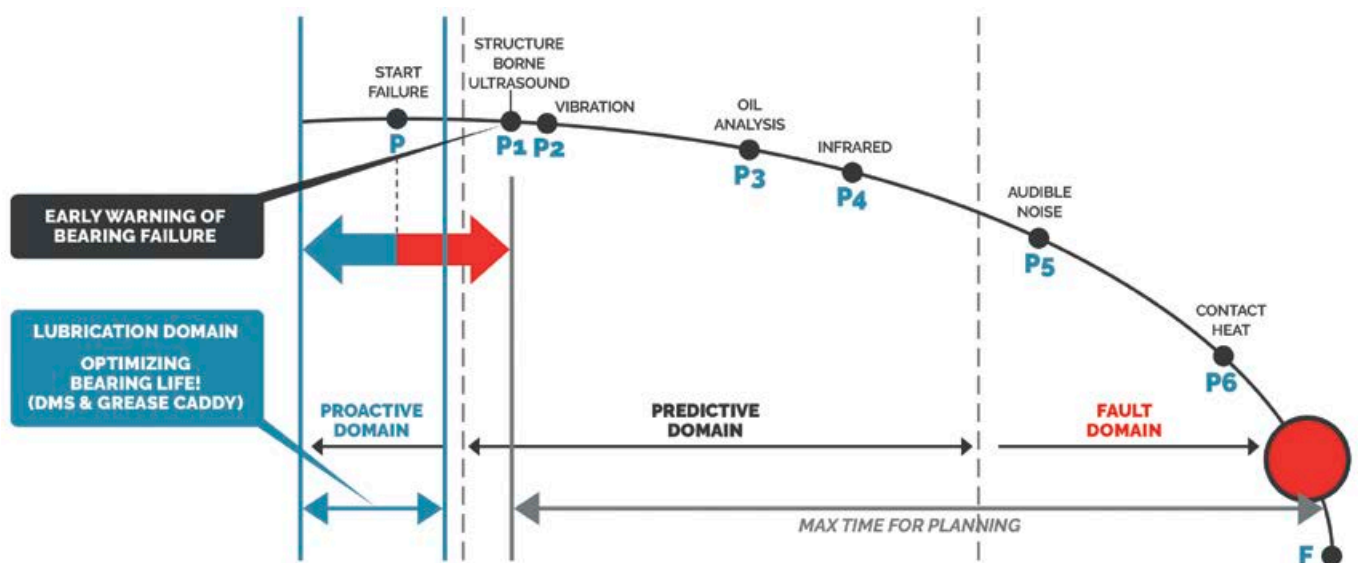
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BEARING CONDITION MONITORING USING ULTRASOUND

Airborne & structure-borne ultrasound has become a major player in bearing condition monitoring.

Once considered just a leak detector, more maintenance & reliability professionals are beginning to realize all of the benefits associated with using ultrasound for condition monitoring applications. The P-F Curve with which we have all become familiar with reflects that trend.



The I-P-F Curve shows Ultrasound as being the first technology that detects a failure that is mechanical in nature such as early stage bearing wear, or subsurface bearing fatigue

It has been said that at least 60% of premature bearing failures can be attributed to lubrication, whether it's over lubricated, under lubricated, using the wrong grease for the wrong application, or contaminated lubricant. Ultrasound instruments can be used to prevent over and under lubricated bearings. Since the source of ultrasonic noise is friction, when a bearing is in need of grease, there is an

increase in friction; therefore, an increase in noise or decibel level. When listening to the bearing that is in need of lubrication and watching the decibel level on the display of an ultrasonic instrument, as grease is applied the inspector would notice a gradual drop in the decibel level, and eventually back down to a more normal level. If the bearing is already over lubricated, as soon as grease is applied,

the inspector would notice a gradual increase in the decibel level, letting them know that the bearing already had enough grease.

How Do I Get Started?

There are two common questions that many first-time users of ultrasound have. The first is, "how do I set baselines?" The

second is, “how do I know if what I’m listening to is good or bad?”

The Comparison Method

One way to get a quick idea as to what is good and what is bad is by using the comparison approach. With this method, the inspector simply compares the decibel level readings at identical points on identical machines. Using this method, the inspector also begins to “train” their ear as to what rotating equipment sounds like, and it will become obvious that a bearing with a particular fault such as an inner race, or outer race defect, will sound much different than a bearing that is in a “good” condition.

The baseline can then be set based off an average of decibel levels at the compared points. The software may even default to the first reading taken and downloaded. The baseline can then be changed as more readings are collected.

The Historical Method

The historical method is the preferred method for establishing baselines and alarm levels in bearing condition monitoring routes. Using this method, the inspector first establishes a route or database in the ultrasound software. The database is then loaded into the ultrasonic instrument. Data is then collected at the various points along the route. When the initial round of data is collected, it may be necessary to collect data more frequently than needed in order to build the history, and get an idea if the decibel readings are remaining similar in the historical readings.

For example, when collecting the initial data for setting the baseline, the readings may need to be taken once per week for 4-5 weeks. Once the baseline is set, the readings can be taken only once per month, or every other month depending on asset criticality and equipment runtime.

Ultrasound Imaging

Through advancements in ultrasound instruments and software, the user can obtain an “image” of the sound that is being heard to analyse, diagnose, and confirm mechanical fault conditions in

rotating equipment.

Examples of Ultrasound Imaging

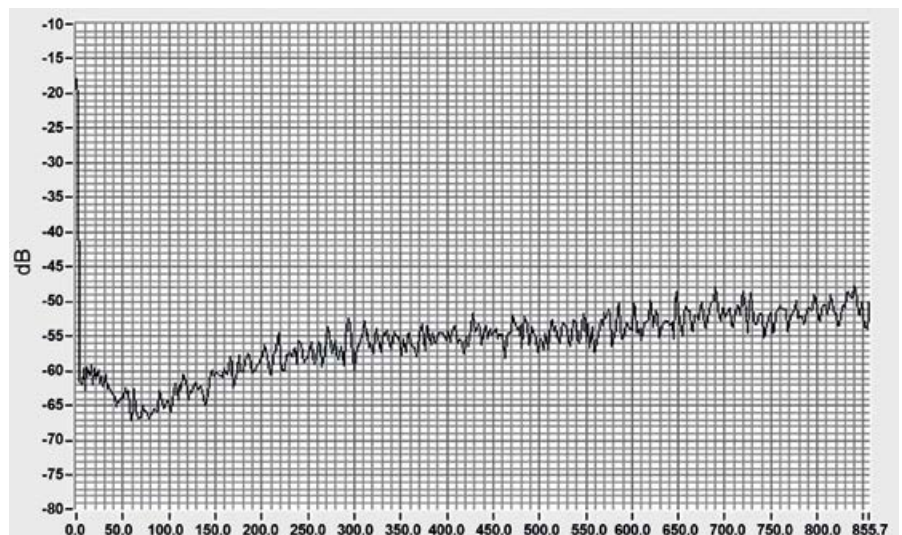
Let’s take an example from two motor and pump combination: 60hp motors powering water pumps. While collecting data, both decibel readings and sound files were recorded. The below screen shots from the spectral analysis software show a comparison between the points “PUMP 3 MTROB 007” and the “PUMP 4 MTROB 010.” Notice the difference between the two points. Both motors are operating under the same conditions, but the Pump 4 MTR OB point has a much different spectrum. If

you were listening through the headset of the ultrasound instrument, it would also have a much different sound.

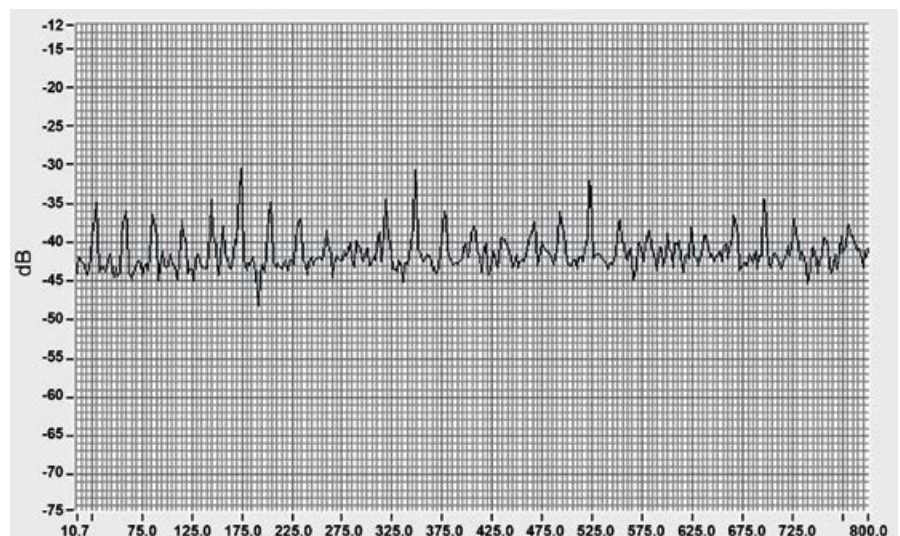
Another image of the Pump 4 MTROB point, captured from on board the ultrasound instrument, can be seen below.

Pump 4 MTR OB from the ultrasound instrument. Notice the distinct 175.8Hz harmonics detected.

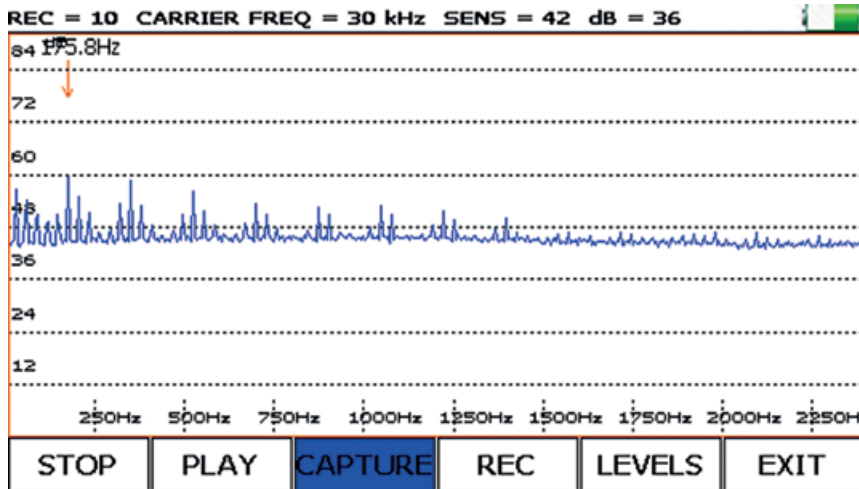
The spectrum analysis software used has a built-in bearing fault frequency calculator. By entering in the speed (rpm) and the number of balls (bearings), an outer race, inner race, ball pass, and



— PUMP 3 MTROB 007



— PUMP 4 MTROB 010



— Pump 4 MTR OB from the ultrasound instrument. Notice the distinct 175.8Hz harmonics detected.

cage frequency are calculated. For this particular motor, the speed was 1750rpm and the type and number of bearings was confirmed and the number of bearings was 10. The fault frequency calculated by the spectrum analysis software that was of interest was an inner race fault at 175Hz. This is the same fault harmonic

detected on the ultrasound instrument. Another interesting point was the fact that the vibration analysis data was collected two days later, and did confirm an inner race fault on the Pump 4 motor outboard point.

Conclusion

Implementing ultrasound for condition monitoring applications is easier than you think. With a short learning curve, ease of collecting data, and remote monitoring solutions, ultrasound can become another valuable tool to use for your condition monitoring efforts.

Lubrication PM's can also become more effective because ultrasound trends will show which bearings need to be lubricated. Therefore, instead of greasing everything on a time-based lube route, only the points that are currently in the lubrication alarm from ultrasound trends are greased until the decibel level drops back down to the baseline dB.

If you're only using ultrasound as a leak detector, I would encourage you to take a more in depth look into condition monitoring with ultrasound.

by Adrian Messer, CMRP
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IMPROVED LUBRICATION PRACTICES?

Regularly, I meet customers who know, believe they know or have heard that an improved Lubrication Strategy will help with their plant and equipment reliability. However, many do not understand what it really means, how to go about it, where to go for help or how to cost justify implementing it.

When maintenance, reliability or management folks decide they want to go forward with an improvement in their lubrication practices, they generally reach out to the suppliers that they are locally involved with. These range from trade or spare parts suppliers, lubrication suppliers, lube equipment suppliers, filtering suppliers, oil analysis companies or Pdm and lubrication service suppliers. The problem is that most do have some Lubrication Reliability competencies, but often that knowledge only goes part of the way and this leaves the company with holes or shortages in their implemented strategy.

Don't worry, there is a solution, **"One system, One Result"**, the OilSafe way.

The European, African and Middle Eastern OilSafe supplier, Enluse BV is only a mouse click away to help you take advantage of the OilSafe way to Lubrication Reliability.

The Story

Attention: If you do not want to know about the complete Lubrication Reliability picture and the financial gains it will bring your plant or your customer's plant, then do not read further, flip the page and keep scanning.

So for those with some interest at heart, let us start with the process to implement Lubrication Reliability.

It all starts with 6 questions or should I say the interested parties ongoing questioning check list.

And that is, will this (or any) action ensure that:

1. I get the right lube into the machine
2. At the right time
3. In the right quantity
4. In the right way
5. In the right condition
6. And kept in the right condition

We call this the **6 Lubrication Rights** and if the answer, at any time, on any one single question is a NO, then there is or will be a hole in the strategy – a hole through which the operational dollars can drain.

So, let us explore a little more.

1. Contamination Control

In the concept of Lubrication Reliability, or you could call it the process of extending machine life, controlling the contamination in the oil is one of the

main actions we need to achieve. Simply put, if the size of contaminants in the oil are greater than the lubrication film thickness, then third party abrasion is happening and the application or component degradation is underway. This in layman's terms we called WEAR.

Note: I have chosen to write the word wear in this article in capitals, simply to bring emphasis to this very high industry cost creator.

Now the interesting thing about WEAR, is that we do not know it is in process, until it is too late – unless of course we are doing oil analysis resulting in the measurement of the contaminants size / level / type and relating this to an established Best Practice objective or standard. For example, the standard could be an established **ISO 4406** standard.

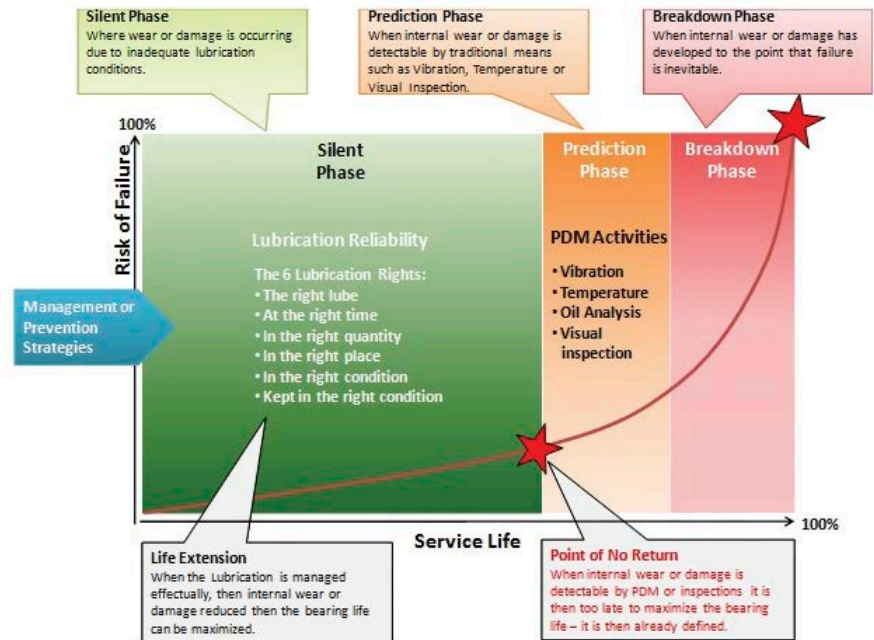
WEAR is what I have coined as the **“Bearing Silent Killer”**. It is silent in its wearing process and it only becomes audible or noticeable when it is too late and then maintenance needs to kick in or in the case where no Pdm or inspection process are in place, a catastrophic machine failure is in the offering. Refer to graphic below.

So to prevent the process of WEAR, one of the main factors we need to control is the contamination in our machine oil. This is a selection of failed or damaged bearings, many resulting from high contamination levels.

Now let us assume we have removed a bearing from a machine and determined it has a very high degree of wear coming from contaminated oil. So let's now ask ourselves the 6 questions:

1. Was the right oil added to the machine, ► **Yes**
2. In the right quantity, ► **Yes**
3. At the right time, ► **Yes**
4. In the right way, ► **Yes**
5. In the right condition, ► **Maybe not, maybe it was dirty.**
6. Was it kept in the right condition, ► **no, the oil had become contaminated.**

The corrective solution to prevent this failure from happening again is to only add clean oil to the machine, using oil analysis to monitor the contamination



levels, filtering the oil when it is dirty and adding desiccant breathers to prevent any future contamination ingress.

So far so good, however a contradiction to the statement that contamination is the cause of WEAR, is that this Silent Killing process can also happen when we have zero contaminants in the oil, simply because we have lost our lubrication film thickness or the oil is no longer capable of doing the job it is there to do – lubricate and protect.

2. Lubrication Film Thickness

Oil is a highly chemically formulated substance and it is used to separate machine or component surfaces from touching or rubbing together and ultimately to prevent WEAR from happening. It is also to eliminate or reduce friction.

It is all about viscosity, which is the most important physical property when defining the right lubrication for any given application. There are a number of factors to be considered when selecting the right viscosity grade for any application, for example speed, load and the operating environmental conditions to name but a few. The bottom line of these factors and others is that we want our moving components to be sufficiently separated in order to prevent WEAR, or, in other words, we need an effective operating lubrication film thickness.

One could make a comparison of

machinery oil to the blood in our body and thus describe oil as the life blood of our machines.

Like the blood in our body, if it's not up to standard we can become ill, so does the machine when the oil is in poor health. Or, as the chemists say, the oil has degraded and when this happens we can lose our viscosity, resulting in a loss of the lubrication film thickness, with metal to metal contact occurring and adhesive WEAR kicking in. Adhesive WEAR is the microscopic bonding of moving surfaces when contact occurs. In a bearing this is often referred to as smearing.

Now let us assume we have had a catastrophic bearing failure and the cause is determined to be adhesive WEAR due to a loss of our lube film. So again let's now ask ourselves the 6 questions.

1. Was the right oil added to the machine, ► **maybe not, maybe we added hydraulic oil (viscosity ISO 46) instead of gearbox oil (viscosity ISO 320).**
2. In the right quantity, ► **Yes**
3. At the right time, ► **Yes**
4. In the right way, ► **Yes**
5. In the right condition, ► **Yes**
6. Was it kept in the right condition ► **No, the oil had degraded and no oil analysis tests had been done.**

The corrective solution to prevent the failure from happening again is to make sure we add the right oil to the machine and using oil analysis to determine it is

operating in a chemically sound condition as well as ensuring that the viscosity is OK.

Now let us ask the same questions for each application when establishing a Lubrication Reliability program.

1. I need to get the right lube into the machine.

We need a labeling system in the lube room, on the dispensing container and on the machine. Preferably colour coded and symbol supported as this will minimize any potential mixing.

2. At the right time.

We need to map the machines and set up a fault free, time based lubrication schedule.

3. In the right quantity.

We need to also establish how much lube should be added at lubrication schedule time.

4. In the right way

We need to use safe and effective dispensing mechanisms.

5. In the right condition

We need to make sure the oil is clean when it is added

6. And kept in the right condition

We need to ensure we are doing oil analysis to determine the condition of the oil, establish a filtering system to keep the oil clean when needed and we need to add desiccant breathers on each key oil application.

3. The OilSafe Way

Most folks in Industry know the name OilSafe. This unique coloured oil dispensing system has been the industries Best Practice for more than 20 years. Today the OilSafe package is more than just a dispensing system; it is a complete Lubrication Reliability package, meaning a one stop shop for your lubrication system needs.

Let's look at the 5 questions again now wearing the OilSafe hat.

1. The right lube into the machine

Coloured based labeling is the common identification process used across the plant. A lube program that wants to

prevent any form of mixing where the wrong lube ends up in the wrong machine is to establish a specific colour and symbol for each lube in use. The foundation of this is a wall chart displayed in the lube room and this information is seamlessly applied throughout the whole of the plant; - lube room, dispensing containers, the machine filling point and the filtering process. The OilSafe unique Visual Lubrication System of products combines to identify, protect and reduce machinery downtime.

2. At the right time

This activity is generally handled by our customers where the lubrication schedules are built into their own Maintenance



Machine	Point	Oil ID	Oil Name	Oil Viscosity	Oil Grade
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9
10	10	10	10	10	10

Fig. 1 Wall chart



Fig. 2 Lube room



Fig. 3 Dispensing



Fig. 4 Fill point label



Fig. 5 Filtering Cart

Management control programs. For example their CMMS program. Some companies do use dedicated lubrication management software and if companies are seeking to acquire such software, Enluse BV can assist in this matter. However, we always point out the options that are available.

Today there are two types of Lubrication Management programs available, Cloud / Web based or PC based and both of them

can be vendor specific or vendor neutral. Vendor specific programs generally mean that one is tied to a specific vendor and their lube data can be at risk if one wants to change the supplier, whereas vendor neutral programs give one more control of ones data.

3. In the right quantity

Too much or too little lube can both cause machinery problems.

It is always recommended before making any changes to lube schedules relative to frequency of oil changes or top ups, that the Original Equipment Supplier is consulted or the machine operational manual studied.

4. In the right way

Poor dispensing is one of the main causes for contamination entering the machine. People often go to great lengths to preserve the quality of their oil only to contaminate it by using filthy containers, pouring it through a dirty funnel or inadvertently mixing it with different oil.

The colour-coded range of **OilSafe containers** provide a fully sealed unit preventing contaminants from entering the oil and easier dispensing without the need for secondary tools such as funnels. With 5 different lid sizes, designed to fit 5 different drum sizes, you can mix and match the components to build heavy duty durable dispensing containers that will meet your oil transfer requirements. See figure 6 next page.

The OilSafe Premium pump is feature rich and can handle up to ISO 680 fluids. It has all the features of the OilSafe standard pump, this heavy duty discharge pump with a colour-coded body collar, has an ultra-comfortable D handle grip design and has fully serviceable internals for maximum life. The dispensing hoses can also easily be converted for quick connect use. Refer figure 7 below.

5. In the right condition

Most people don't know the new oil can be dirtier than the oil operating in their machines and the lube room can be a source for adding additional contaminants to the new lubricant. In the past, traditional machinery lubrication has been seen as a function of low



Fig. 6 The OilSafe line



Fig. 7 OilSafe Premium Pump

importance, being messy work, requiring limited skills and lacking organization and structure. **This is changing.**

The OilSafe Bulk Storage System puts structure and organization into the lube room, with its easily identified colour-coded containers, oil pre filtering before dispensing and coming in a range of storage containers to suit consumption levels. An OilSafe Bulk Storage System will enable you to take immediate control over your lubrication workflow process and get your lubrication storage area and practices clean, efficient and compliant. See figure 8.



Fig. 8 OilSafe Storage System



Fig. 9 Lustor Storage System



Fig. 10 Lustor wall mounted System

The Lustor System is a modularized storage and dispensing also adding structure and cleanliness to the lube area. The system of 125 and 250 liter tanks safely stores your oil and pre filters it before use.

The Lustor System consists of standalone units and is designed as a “**Connect and Operate**” unit. Simply connect the air supply, turn on the tap and the system starts working. Refer to figure 9.

The Lustor wall mounted system offers the same benefits as the modular standalone units, but pumping directly from the suppliers oil containers. Refer to figure 10.

6. And kept in the right condition

Lubricating oils can deteriorate or change in operation. They can lose their additive pack, they can become contaminated and they will ultimately cease to provide the protection against the process of WEAR.

The Reliability of the machine lubrication needs to be managed in order to ensure that its integrity is maintained.

Maintaining the Lubricant Reliability is a 3 stepped process.

- Adding Desiccant breathers to prevent contamination ingress.
- Filtering the operating oil to eliminate contaminants.
- Using Oil Analysis to monitor the lubricant condition.

Air Sentry Breathers are a global **Best Practice** in stopping contaminants from entering the oil. The new **Guardian range** of breathers with their replaceable cartridges and check valve technology is the most economical breather on the market today. Refer to figure 11.

OilSafe's ground breaking **Filtration Units** extends the life of your industrial oils, saving you time and money. They help maintain the purity of the oil in operation and eliminate cross-contamination with colour-coded/error-proof, flat face, zero leak quick connects. Refer to figure 12 and 13.

FanPro, the Enluse fluid analysis



Fig. 11 Guardian



Fig. 12 FilteringCart



Fig. 13 Wall mounted filtering unit



Fig. 14 Oil Analysis System

program is a global Best Practice in Oil Analysis. Supported by laboratories with state of the art analysis technologies and its web based management control and trending software you will know at any time the condition of your oil - a simple process.

Summary

One system, one result – the OilSafe way. We are your partner and pathway to implement Lubrication Reliability.

Gain the benefits of improved plant and equipment reliability and talk to Enluse or any one of our wide network of European dealers today or visit our website:

www.enluse.com



Author : Ian Knight
General Manager at Enluse B.V.

Improved Plant Reliability awaits you!

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If you've always wanted to work independently and partner with a global company, your place is with us. We work with 80+ countries and are currently expanding to penetrate more markets, so we are looking for business partners all over the world. If you have working experience in the bearing industry, we invite you to visit us in our Head Office in Lithuania to discuss becoming a Sales Agent in your country.

WHAT'S IN IT FOR YOU?

- Zero initial investment – nothing to lose
- 5-10% commission on products sold
- Marketing and service support
- Opportunity to become a branch company
- Confidence about products with warranty

WHY IS IT WORTH REPRESENTING CRAFT?

KEY FACTS:

- Have one of the biggest bearing stock in Europe
- One of the top 3 in CIS, Latin America & Eastern Europe
- Globally recognized brand (present in 80+ countries globally)
- We have one of the widest ranges of Industrial and Automotive bearings in Europe
- We own our factory for tapered roller bearings
- We have modern network of warehouses and worldwide consignment

OUR QUALITY & PRICE LEVEL:

- We have our own Bearing Quality Control Laboratory where we double-test all production
- Quality is measurable, free samples are available to make sure that it is consistent
- We take responsibility for our quality and offer warranty and professional service
- Competitive prices assurance

SIGN UP

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www.craft-bearings.com/en/agents

“



We started working with CRAFT Bearing in 2010. Our partnership started for us as a sales agent in Ukraine region. After five years of successful work with CRAFT Bearings I acquired exclusive distributor status in 2015 making over 2 million+ USD in annual sales. The quality control, good product and marketing support and great margins on products that CRAFT Bearings provide makes working with them pure pleasure.

Pavel Chailenko
Ukraine

“



I'm very excited to work with CRAFT everyday. In 2015 I've became a sales agent in Panama. I was surprised how quickly I've penetrated my home market and how positive feedback I've got from the end users, therefore in 2016 I've acquired exclusive distributor status in Panama and repainted my office in orange color fully. Proud to be part of CRAFT family!

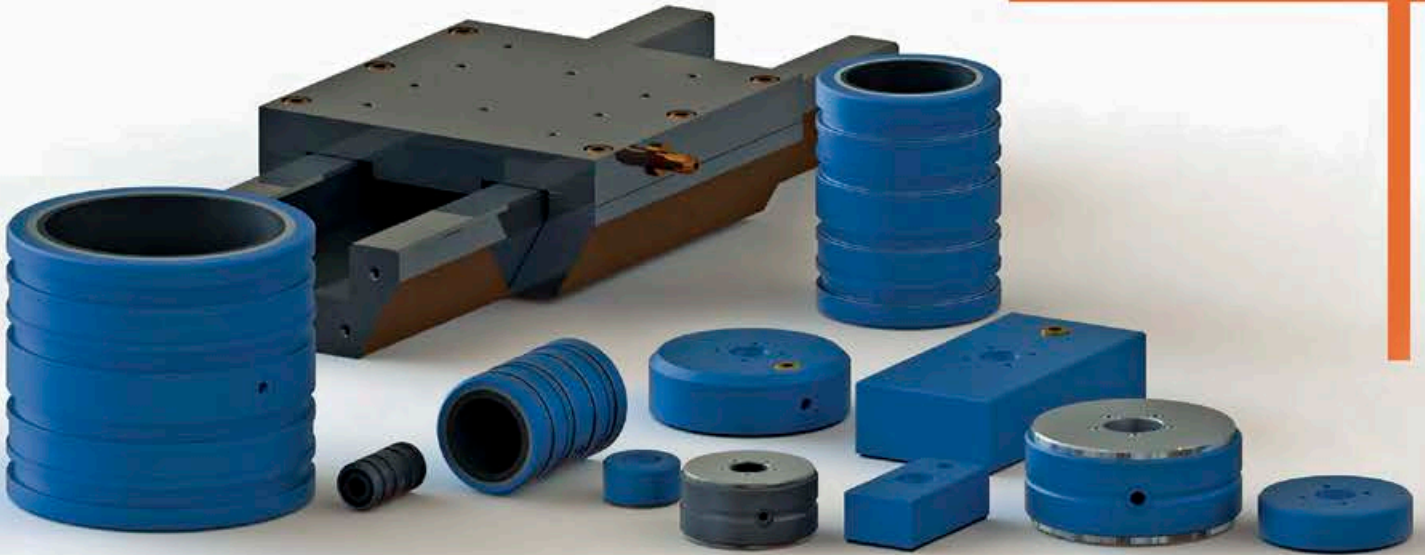
Cesar Niada
Panama

“



Croatia is a special market which demands optimized price & quality and CRAFT is exactly so! I enjoy working with CRAFT where brand itself as well as marketing & technical support, do most of the job due to good reputation and reliable products.

Danijel Prišlec
Croatia



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What Happened in the Bearing Industry First Half of **2017**

January

03

Schaeffler acquires Compact Dynamics



The automotive and industrial supplier Schaeffler has today concluded a purchase contract with SEMIKRON International GmbH for the acquisition of 51% of the shares of Compact Dynamics GmbH, a manufacturer of high-performance electric motors. At the same time, Schaeffler and SEMIKRON have agreed a cooperation for the development of power electronics systems and the integration of power electronics components. With this acquisition and cooperation, Schaeffler is expanding its expertise in electric motors and power electronics for the

development and production of electric drives.

“As part of our “Mobility for tomorrow” strategy, we regard electric mobility as one of the major opportunities for the future. With the acquisition of Compact Dynamics and the cooperation with SEMIKRON, we are adding to our existing technology portfolio and opening up new opportunities for growth”, said Klaus Rosenfeld, CEO of Schaeffler AG.

January

09

72% more space at new NSK European Distribution Centre

NSK has commenced the construction of a new European Distribution Centre (EDC) just 4km from the facility's existing location at Tilburg in the Netherlands. Measuring 17,357m², the site will offer 72% more warehouse space and accommodate 51% more pallets, while shelving and docking space will both be doubled. The investment in this facility will benefit customers through even more reliable and fast deliveries.

Tilburg has been the home of NSK's EDC for the past 14 years. However, with demand for the company's products continuing to grow, NSK has taken the decision to relocate to the Vossenbergh area of the city, where

a new facility will facilitate an expansion in logistics capabilities. Groundworks are finished and construction of the warehouse, which includes a 1900m² mezzanine floor, has now begun.

The new warehouse will stock industrial and automotive bearings for customers located across Europe, including Russia and Turkey, as well as the Middle East.



There will be more space and increased mechanisation at the new NSK EDC, leading to even greater logistics efficiency

Japan's JTEKT buys out Sona Group in their steering JV

Japan's JTEKT Corporation has acquired Sona Autocomp Holding Limited's (SAHL) 25.12 percent stake in their JV, Sona Koyo Steering Systems Limited (SKSSL), for about Rs 419.28 crores. Besides, JTEKT and SAHL, Maruti Suzuki India also owns 6.94 percent stake in SKSSL.

Sona Koyo and JTEKT came together in 1985 to start production of steering in India. While JTEKT has a technical assistance agreement with SKSSL for steering parts, it also sells semi-processed products and parts to SKSSL. Sona Koyo Steering Systems Limited, the flagship company of the auto component maker Sona Group, is currently the largest manufacturer of steering systems for the passenger car and utility vehicle market in India. With the acquisition of additional SKSSL shares, JTEKT will deepen its relationship with SKSSL, and combined efforts in providing swift customer services and



meeting their expectations by a multitude of business administration in various areas including design, purchasing, and quality will help JTEKT provide better products and services to the customers

SKF destroys 15 tons of fake bearings

SKF has recently completed legal proceedings against a dealer of counterfeit bearings in Greece. Initiated in 2009, a total of 15 tons of counterfeit SKF bearings were seized as part of a raid at a dealer's warehouse in the area of Piraeus, with whom SKF had no business relationship during these years. The bearings have now officially been declared counterfeit by the Greek courts system, resulting in their destruction.

The raid in 2009 resulted in the seizure of 17,000 pieces of counterfeit rolling bearings, with a total weight of 15 tons and a market value of over EUR 1,000,000. These have now been destroyed at a metal recycling facility in Greece, by crushing them in a scrap press, to ensure they will not resurface on the market.

A wide range of companies from the marine and other industrial sectors were affected by the counterfeit SKF bearings sold by this non-authorized dealer in the Piraeus area. Instead of getting the premium quality product they thought they were purchasing, the customers ended up with products of unpredictable quality and performance.



What Happened in the Bearing Industry First Half of 2017



“We are very happy that this case is officially closed and has resulted in a positive outcome for SKF and our customers. We will continue to fight the problem of counterfeit products and importers in Greece. This is vital for us in order to protect our customers and their business as well as the reputation of the SKF brand”, says Rania Patsiopoulos, Managing Director, SKF Hellas S.A.

SKF actively supports law enforcement globally to stop the trade of counterfeit SKF products. This trade is illegal and may lead to substantial fines or imprisonment.

“Counterfeit industrial products like bearings are not bought intentionally by customers, so the best way to fight counterfeit is to raise awareness. Customers who accidentally purchase counterfeit products are being cheated financially and risk damage to their machinery and expensive downtime”, says, Tina Åström, Director, SKF Group Brand Protection.

The financial damage resulting from the counterfeit products is difficult to quantify. Lost sales and significant loss of image are definitely some of the consequences. Dealers that sell counterfeit products risk both financial damage as well as their credibility and reputation.

End customers that install counterfeit components will suffer the most. A recent case proved once again that significant damage can be caused by the failure of a

rolling bearing. An anonymous customer says: “We spent EUR 100,000 on large size bearings, purchased from an un-authorized supplier. We needed the bearings urgently and the supplier matched our required lead time. Their failure was a fact after only a few months, while the expected service life was several years. We faced costly downtime and broken promises to our customers. All this could have been avoided, by more awareness and caution in our sourcing. We will not allow this to happen again.”

To distinguish a counterfeit bearing from an authentic SKF bearing often requires expertise. Customers that suspect they might have been sold counterfeit products should use the SKF Authenticate app for smartphones to take and send photos of suspect products directly to SKF for verification. The app can be downloaded for free from Apple App Store or Google Play. They can also e-mail pictures of the suspected bearings to genuine@skf.com. All premium brands are affected by counterfeit products. SKF, along with other bearing manufacturers affected by counterfeiting are working to fight against this problem and have launched a counterfeit awareness campaign through an umbrella organization, World Bearing Association (WBA). The campaign aims to make customers aware of the risks and problems with counterfeits. More information can be found at

www.stopfakebearings.com





Nomo has spent considerable time and effort creating new online digital solutions, aimed at increasing customer benefits.

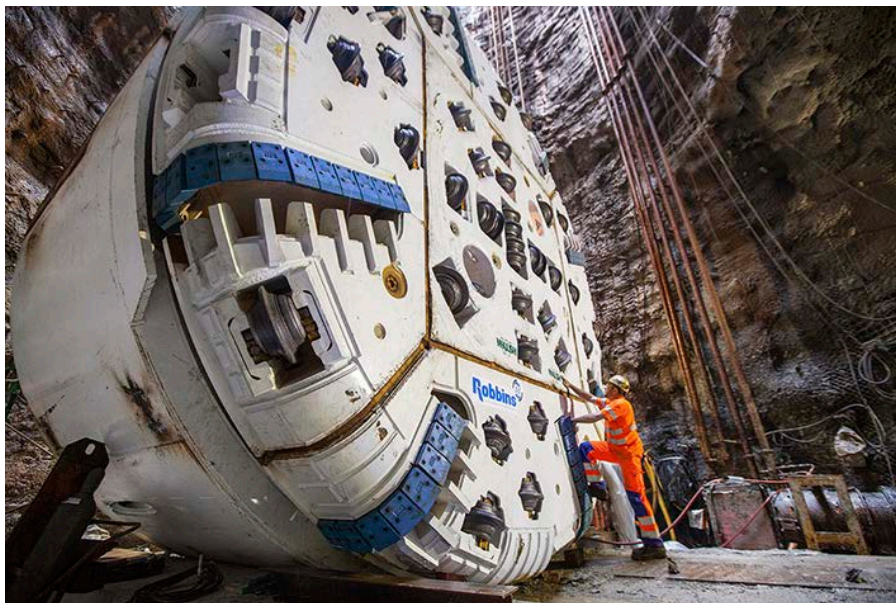
The latest solution is a brand new digital product catalogue that incorporates an e-commerce solution.

– Most importantly, we have spent a great deal of

effort on creating good search functionality” explains Henrik Walter, Sales & Marketing Manager at Nomo Group.

The first step in our digitalization journey was to create a joint web platform for the entire group. This platform is now being expanded to incorporate an extensive digital product catalogue with E-commerce functionality.

One of the great challenges when creating the digital product catalogue has been to cover the wide range of products and large number of manufacturers we represent. Therefore, we have invested heavily in the infrastructure handling and quality assuring the massive amount of data. -We realize that our customers now want to access product information online and want to be assured that the data is correct and quality assured. In an ever faster moving world they also want instant commercial and availability information all in one place.



With the delivery of the first thrust bearing for the Robbins Company's tunnelling machine, the Components Division of the Liebherr Group has now made its appearance on the American tunnelling market. The two-row roller bearing with a diameter of 2,500 mm ensures reliable shield rotation of the propulsion machine over the entire tunnel length. The thrust bearing's reliability is essential in tunnel construction, since replacing it during tunnelling is very complex and costly. The shield of the tunnel boring machine (TBM) has a diameter of three and a half metres and is meant for supply tunnels, but TBMs can reach a size of 14 metres or more for road, railway, and other tunnels. In addition to the one-piece bronze cages, a special feature of the Liebherr roller bearing is the pre-tensioned holding track. It is pre-tensioned using disc springs, so that the rolling elements of the holding track are in contact with the track in all load

situations.

In this application too, Liebherr bearings meet high demands in terms of reliability and service life. In spite of fierce local competition, Liebherr succeeded in being selected as the component supplier. Robbins tunnelling machines are exposed to extreme loads and environmental conditions, such

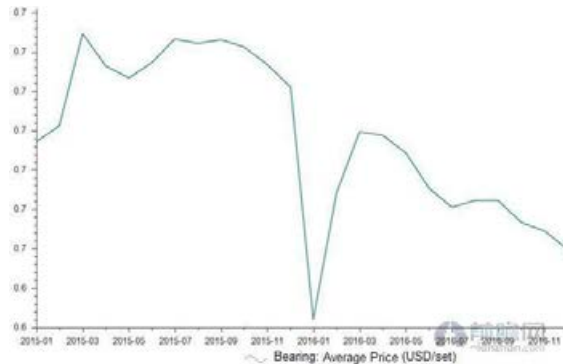
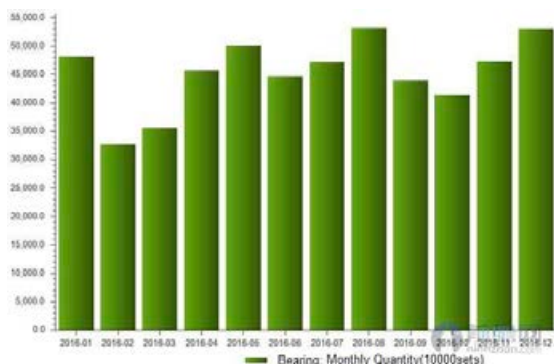
as high temperatures and coarse dirt and dust.

“When selecting the bearing manufacturer, Liebherr impressed us with its application engineering expertise as well as its high production standards. That is why we like to work with companies who know from personal experience how these conditions affect the technology and components”, explains Dale Spurio, Global Sourcing Manager for The Robbins Company. Thus, Liebherr was awarded the project.

The Robbins Company has been operating internationally in the field of tunnel boring machines for more than 60 years. After commissioning, the tunnel boring machine will be used by an end customer in China.

Chinese bearing prices decreased with almost 6%

According to data from qianzhan.com, China's export of bearing products in 2016 reached approximately 5.4 billion sets, totally valued \$3.506942 billion, with the annual average price of exported bearing \$0.65 / set, down 5.96% over 2015. Following are the quantities of exported bearing by month in China in 2016:



Due to the limitation of capital, technology, human resources, research capability, etc., bearing enterprises in China are great in number yet mostly small in scale, and compete with each other mainly on the low- and mid-end market. As the low- and mid-end bearing products occupied the main bearing export, export enterprises in China, as a result of the fierce competition, dramatically cut their prices to seize the market share.

At present, in order to develop and produce high-

end products, bearing manufacturers in China keep increasing investment in the production equipment, the testing equipment and the development of production lines etc., introduce overseas advanced production technology and upgrade equipment in technology, making bearing products close to or up to the international advanced level in quality and stepping into international high-end markets as top bearing manufacturers.

NSK expands production at Kielce plant

NSK has commenced the expansion of production at its plant in Kielce, Poland, with the first half of the project scheduled for completion by the end of March 2017.

The facility at Kielce is NSK Europe's largest plant, manufacturing ball bearings for the automotive and industrial marketplaces. The company now plans to utilise its strength of streamlined production processes, from initial forging to final assembly, to introduce the manufacture of further product ranges. NSK has already started the renovation of a building with floor space of almost 10,000 square metres in order to create space for further development. Once complete, the company plans to commence the



Ball bearing manufacture will be joined by further products from the NSK range as a result of expansion at the company's Kielce production plant in Poland

manufacture of HUB1 automotive wheel hub bearings in Kielce and introduce cylindrical roller bearing production as part of a major new project for a leading automotive OEM. Additional deep groove ball bearing lines will also be introduced for automotive clients.

Kielce is already a major production plant for the NSK Automotive Bearings business in Europe. Existing production includes ball bearings for chassis, powertrain, engine and electrical motor applications. A major department of NSK's European Technology Center (ETC) is also housed at the Kielce plant, where the team focuses on product development and testing.

NSK has an extensive production network in Europe – further plants are located in Germany and the United Kingdom. To safeguard security of supply around the world, every NSK product is made at a minimum of two plants, thus delivering peace-of-mind for customers.

March

15

Liebherr expands its portfolio with tapered roller bearings

To access further market segments, Liebherr Components has been manufacturing tapered roller bearings since 2016. As a pilot product, the company produced a tapered roller bearing of considerable dimensions right from the start. The large bearing for a specific project has a diameter of over six meters and weighs 32 tonnes. The bearing consists of three individual rings, made from high-alloy quality steel. Both induction-hardened raceways are fitted with tapered rollers, enabling the transfer of a radial load of several thousand tonnes.



Liebherr tapered roller bearings fulfil the highest requirements in terms of precision and load capacity.

The tapered form of the rolling elements ensures optimum rolling characteristics. The play-free bearing mounting makes the tapered roller bearing particularly suitable for the highest precision and load capacity requirements. The rolling elements are conveyed precisely in the raceway by bronze or brass cages. Depending on the application, appropriate

seal concepts are available from Liebherr. Along with lip seals, shaft seals can also be deployed, if needed. This prevents dirt penetration and ensures optimum lubrication throughout the entire period of use. Grease lubrication and oil lubrication are both possible for the tapered roller bearings.

March

30

BOWMAN Acquires John Handley Bearings



Bearing specialist, Bowman International, has announced the acquisition of the business of the Midlands based, John Handley Bearings Ltd.

Committed to growing the John Handley name under the umbrella of its own brand, Bowman will work closely with the highly-experienced John Handley team to improve stock availability for its three key technical partners: Thomson Industries, Cooper

Bearings and NSK linear.

Commenting on the acquisition, Paul Mitchell, Managing Director of Bowman International, said: "John Handley is a well-respected and established family-run business, which offers a range of high-quality Linear bearings, Split bearings and Rod Ends. These products complement our existing portfolio and together we have identified many positive

synergies between our two companies – including a customer- centred approach to innovation and a long-standing commitment to service and quality.”

Lucie Tait-Harris, Commercial Director for John Handley Bearings, added:

“The time is right for our business to seek the strength and financial backing of a larger company and we feel reassured by Bowman’s commitment to retaining the John Handley Bearings identity. Our technical partners and customers are supportive of the acquisition and we are confident that together we can enjoy further growth of our respective businesses.”

Over the coming months, John Handley bearings will benefit from a new website, advertising and reliable levels of stock availability for its expansive customer base, whilst Bowman will benefit from a Midlands-based stock holding of its plain bearing portfolio, such as the innovative BowMet®, Oilite®, Bowman Oilless® and wrapped bearing ranges.

With 50-years of industry heritage, John Handley Bearings will benefit from a period of brand modernisation as it becomes ‘John Handley Bearings, a division, of Bowman International Ltd’. Moving forwards, Bowman envisages larger premises

for its new division to accommodate improvements in logistical capacity and supply chain management; meaning quicker, more reactive product supply throughout much of the UK.

Speaking in support of the acquisition, Darren Perry, Regional Sales Manager for Thomson Industries, one of John Handley’s technical partners, said:

“Thomson Industries is delighted to hear that the future of John Handley has been secured thanks to this acquisition. Even at this early stage in the transition, Bowman has already demonstrated its commitment to maintaining and growing the close-working relationship between Thomson and John Handley Bearings.

“John Handley is a key part of our distribution network and we are confident that with Bowman’s backing, our mutual customers will benefit from Handley’s future stability, improved stock levels and more responsive delivery capabilities.”

David Burns European Sales and Marketing Manager of Cooper bearings said “John Handley is a long-standing and highly valued technical and sales partner of Cooper bearings and will continue to count on our support given the renewed impetus provided by Bowman.”

May

01

NTN-SNR’s New NLGI Grade 3 Grease was lauded as the most successful new product

For those who have missed Automechanika Dubai in May 2017, the HEAVY DUTY EP3 High Load grease was lauded as the most successful new product in terms of visitor turnout during the three day event. Made by leading bearings manufacturer NTN-SNR, the European arm of Japan based NTN Corporation, this grease type for heavy duty applications is the first in its range to have NLGI grade 3 specifications suitable for Middle East and Africa’s (MEA) humidity and hot temperatures.

History Behind the Innovation

“Mineral Circles Bearings (MCB) and NTN-SNR came up with the idea of having a grade 3 grease to fulfill the needs of the MEA market,” says Hassanein Alwan, MCB’s Marketing Director. “The foreseen demand for a high performance lubricant that can withstand MEA’s environmental conditions is significant to longer machine service life and operational efficiency”, he added.

Applicable for bearings used in truck wheel hubs and industrial machineries such as conveyors, crushers,



water pumps, high-powered electric motors, and lifting devices, this French made quality grease is formulated to provide optimum protection from contaminants, liquids, friction, heat, plus corrosion due to its following composition:

Grade 3 (NLGI grade rating)– Texture is comparable to vegetable shortening which makes it stiff enough to prevent leakage. Refers to the physical characteristic of the grease



MCB's Marketing Director Hassanein Alwan at Automechanika Dubai

Mineral Oil (Base Oil)– Suitable for industrial or heavy applications
Lithium soap (Thickener)- Binds well with mineral oil making the grease more resistant to speed, load, and high temperatures

Extreme Pressure/EP (Additives)– Has chemical formulation suitable for heat protection and premature damage

Perfect Combination

According to NTN-SNR experts, improper lubrication accounts for 55% of premature bearing failure which is mostly caused by insufficient knowledge or know-how. Therefore, getting a trusted supplier with in-house grease and bearing experts will be handy for any sudden or unprecedented breakdown.

To ensure equal lube distribution to a bearing's rollers or balls and raceway, MCB's engineers recommend greasing a third of its empty space and manually rotating it prior to installation. This way, sufficient bearing protection from liquids, overheating, friction, and corrosion coupled with energy efficiency can be guaranteed.



MCB's Marketing Director Hassanein Alwan at Automechanika Dubai

May

05

Timken Acquires PT Tech, Adding Industrial Clutches and Brakes to Its Mechanical Power Transmission Portfolio

The Timken Company, announced that it has acquired the assets of PT Tech, Inc., a manufacturer of engineered clutches, brakes, hydraulic power take-off units and other torque management devices used in mining, aggregate, wood recycling and metals industries.

"We are pleased to add industrial clutches and brakes to Timken's growing portfolio of mechanical power transmission products," said Richard G. Kyle, Timken president and chief executive officer. "This acquisition allows us to better serve our customers by offering a broader, more diverse package of products and services. The addition of PT Tech will also provide ample growth opportunities, as we leverage our portfolio to drive growth across complementary markets around the world."

Based in Sharon Center, Ohio, PT Tech serves an established original equipment customer base primarily in North America. In 2016, sales were approximately \$20 million.

This acquisition advances the company's strategy to grow its portfolio of mechanical power transmission products to complement its strong position in engineered bearings. In recent years, Timken has completed a number of acquisitions featuring products adjacent to its core bearing lines. This includes belts, gears and gear drives, chain, couplings and lubrication delivery systems, as well as a variety of related services, all marketed under strong industrial brands including Timken®, Philadelphia Gear®, Drives®, Lovejoy® and Interlube™.

EPTDA Welcomes 4 New Member Companies in the 1st Quarter of 2017

The EMEA Power Transmission Distributors Association (EPTDA), the leading organisation for the mechanical Power Transmission and Motion Control (PT/MC) industry in Europe, Middle-East, and Africa, is welcoming 4 new member companies in the first quarter of 2017: two new distributor companies – Hoyer and Partool – and two new manufacturer companies, Thompson Couplings Limited and Pennine Industrial Equipment Limited. “EPTDA’s executive platform continues to attract new member companies, a unique place where key players gather, discuss the latest in the industries and exchange experiences while building new business relations” comments Hans Hanegreefs, EPTDA’s Executive Vice President.

HOYER

Hoyer is an international preferred supplier of electric motors and power transmission with headquarters in Denmark and represented through subsidiaries and sales offices across the globe. We pride ourselves on being an elite enterprise with the highest attention to service and support – a company where dedication, competitiveness, and reliability are second to none.

PARTOOL

PARTOOL, founded in 1949, has 3 branch locations in Belgium (Ostend, Ghent and Brussels). It is a



well-known supplier of highly professional welding equipment, power transmission components, maintenance products and industrial gases. The made-to-measure “PARTOOL” web shop is ready to meet the needs of the industrial customer 2.0.

THOMPSON COUPLINGS LTD

Thompson Couplings is an Australian designed and patented manufacturer of high quality, reliable and durable alignment eliminator couplings and constant velocity joints, used in a wide variety of industries.

PENNINE INDUSTRIAL EQUIPMENT LTD

Pennine Industrial Equipment was founded in 1968 by Leonard Hobbs as “Pennine Technical & Design Services Ltd” and to this day remains a family run business. Pennine Industrial Equipment has been located at our current premises since 1984 with numerous expansions to the site to accommodate the growing business.

HARP is approved supplier of components for Schaeffler Group

In February 2016 it was concluded the Master Agreement on cooperation, according to which HARP can supply components of bearings to all plants of the Schaeffler Group. In May 2017, HARP received the confirmation certificate.

The Agreement was preceded by the technical audit, which confirmed that HARP is able to meet all requirements on quality and delivery terms. In 2016, the first batch was delivered to one of the Schaeffler Group plants in Debrecen, Hungary.

Specially on the Schaeffler Group’s request HARP has mastered the manufacture of three types of taper bearing rings for the automotive industry, represented under the FAG trade mark.

“This is a brand new range of products for HARP, and the plant has successfully mastered the manufacture”, says the General Director of HARP Vladimir Kokhanov and adds that in the nearest future the production volume of mastered components will be increased.

In the future, HARP plans to expand the range of products manufactured for the Schaeffler Group, including forgings, and also start deliveries to other plants of the corporation.

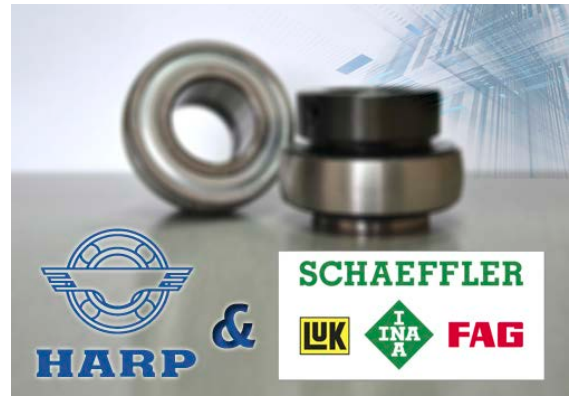
“We are talking about mastering of dozens of types”, says Roman Girshfeld, Vice President Sales and Marketing of the UPEC IG, adding that HARP is the only company in the CIS that get a status of an approved supplier for such global giant as

Schaeffler Group. “This shows that manufacturing facilities and products of HARP meet the highest European requirements”, notes Mr. Girshfeld.

“Getting the status of an approved supplier of bearing components for one of the world leaders is a new stage in the development of the plant, which opens new prospects and new opportunities for us”, adds Mr. Kokhanov. – At the same time, this confirms the highest level of the business management system, quality, control means, technologies, equipment, manufacturing culture. All this together give an opportunity to receive recognition of the quality of products, level of production and organization of production processes of HARP from the world’s “giants” of the industry”.

It should be mentioned that HARP is also a certified supplier for SKF. In 2009, the quality management system for manufacture of components for SKF was certified for compliance with the requirements of the international standard ISO/TS 16949 “Quality management system. Particular requirements for the application of ISO 9001 for production of automobiles and relevant spare parts”.

Over the past 15 years, the company has been carrying out a comprehensive technical re-equipment, which covers all production stages. As a result, the plant got the European level of manufacture. HARP has formed one of the largest fleet of high-precision CNC modern equipment in Ukraine, and kept the position of the largest in the CIS and the only enterprise in Ukraine that manufactures bearing products. The state-of-art equipment from domestic and world leaders in machine engineering, as well as well-established quality control system enable HARP to manufacture high-precision products, which meet all the latest technological standards.



Since 2000, the company has been using an integrated quality management system that meets the requirements of international standards ISO 9001, ISO/TS 16949 and requirements for the environmental management system ISO 14001 in the manufacture of ball and roller bearings and components. The main directions of the company’s development strategy are mastering of the new types of radial bearings with short cylindrical rollers, strengthening of positions as a manufacturer of bearings for railway rolling stock, development of ball bearings of a higher accuracy class, manufacture of hot-forged and turned semi-finished products for automotive, railway and industrial bearings, keeping leadership in the manufacture of bearings for agriculture.

The plant constantly develops new innovative products. Only for the last year HARP has mastered more than 100 new modifications of bearings and bearing units. And for the period from 2010 to 2016 the plant has manufactured 24,6 millions of ball bearings and 4,2 millions of railway bearings. Deep understanding of the automotive market, an extensive knowledge base and strong design bureau allow HARP to manufacture high-quality products that meet the highest standards of world engineering.

May

20

ZWZ has built a global bearing simulation center with Romax

ZWZ Group and the United Kingdom Romax Technology Co., Ltd. held a strategic cooperation agreement signing ceremony. They will work together to build a global bearing simulation technology center, dedicating to the research and application of key areas of bearing simulation technology. Chairman of ZWZ Group Meng Wei and Hu Xiaobing, the general manager of Romax, signed a strategic cooperation agreement, and started up global bearing joint simulation technology center, which symbolized that the ZWZ Group simulation technology reached a new high.

UK Romax is the world leader in drive, gearbox industry software, simulation and engineering services, and its computing methods and ideas in the field of bearings have been adopted by international



standards several times. Based on the next generation of Internet and industry Development trend, they successfully developed the cloud-based online bearing selection calculation and collaborative development platform, providing qualified and efficient

customization services.

In his speech, Mr. Hu said that Romax will invest in the world's best bearing expert team resources at the Simulation Technology Center, using the cutting edge bearing simulation technology to share the most

advanced product development process. In the future, they will also work on large megawatt offshore wind turbine bearings, RV robot reducer bearings and other fields to help ZWZ high-end products further expand the international market.

May

25

Emerson Bearing Boston Expands Line of Bearings for Robotic Applications



Emerson Bearing Boston, a bearing company catering to Original Equipment Manufacturers (OEM) and Maintenance, Repair and Operations (MRO) markets around the world, has expanded their line of thin section bearings.

Lightweight, versatile, space-saving bearings

Used in a wide range of applications, from medical automation and robotics to high tech – thin section bearings have a compact, lightweight design. They are ideal for various robotic applications including human assist, pick and place, semiconductor, and medical. Since they are often used when space limitations or specific design configurations prevent

the use of conventional bearings, thin section bearings allow for versatility in many applications and come in a range of contact angle designs, including radial contact, angular contact, and four-point contact.

Emerson Bearing's expanded thin section bearing line includes Barden, FAG, IGUS, IKO, INA, GMN, DURBAL, Nachi, NTN, RBC and Torrington brands.

Unlike radial ball bearings, thin section bearings' cross diameter remains the same regardless of bore size, and as such reduces system costs and streamlines overall design. High-tech applications often require custom bearings with special materials, surface coatings, or lubricants in order to meet specialized machine needs. Thin section bearings can effectively meet these types of application requirements, including very low or uniform torque, high positioning accuracy, corrosion resistance, and compatibility with very clean environments.

June

07

Schaeffler Makes New Investments in South Carolina

Schaeffler is expanding its American Fort Mill plant in addition to improving infrastructure and the working environment. Schaeffler is creating 105 new jobs at its location in South Carolina, investing 36.5 million dollars.

The Schaeffler Group celebrated the expansion of its Fort Mill plant based in the US state of South Carolina. At the same time, a new office building was opened which has been adapted to the new working environments of Schaeffler's "New Work" initiative. Maria-Elisabeth Schaeffler-Thumann, family shareholder, attended the opening ceremony together with Georg F. W. Schaeffler, Chairman of the Supervisory Board, and Klaus Rosenfeld, CEO of Schaeffler. The globally active automotive and industrial supplier has created over 100 new jobs at the Fort Mill location.

50 years of success

Schaeffler has been present in South Carolina for almost 50 years. In her speech during the opening ceremony, Mrs. Schaeffler-Thumann looked back on the success story of the Fort Mill location: "The USA as a location has always been of great importance to our family. For all those years, we have demonstrated our strong commitment to South Carolina through capital investments." Furthermore, she pointed out the importance of employee development as part of the corporate culture and values, and stressed: "The key to success are highly-qualified employees, which is also true for the US, and I am proud of our trainee program that has been in place in the USA since 1980."



Creating values, continuing investments

Schaeffler has invested around 36.5 million US dollars, which equals approximately 32.5 million euros, in order to expand its production capacities of one of its two Fort Mill plants. Moreover, a new, multi-functional administration building has been set up, as well as a new plant entrance that has been adjusted to accommodate the location's enlargement and increasing traffic. "We want to deliver long-term value as a true partner. Therefore we are committed to further grow our business in the Americas, and invest in the US in capital and in the people both in the industrial and the automotive markets," said Klaus Rosenfeld, CEO of Schaeffler AG.

Production capacities have been increased

Expanding the plant's production space by around 3,250 square meters has increased capacities in the areas of stamping, heat treatment, and mounting of axial bearings, which are used in 8, 9, and 10-speed automatic transmissions. The new administration



building offers around 6,000 square meters of space for modern office work places and, in addition to that, a multimedia conference center, and a company restaurant.

Around 6,000 employees in the USA

Schaeffler also operates plants in Spartanburg and Cheraw in South Carolina in addition to the plant in Fort Mill, where the company's US headquarters are based. In total, Schaeffler employs approximately 6,000 employees at eight plants and three research and development centers.

June

12

Advent International acquires IPH and Brammer from PAI Partners

Transaction creates a leading European distributor of industrial supplies through the combination of Brammer and IPH.

LONDON and PARIS, 12 June, 2017 – Advent International ("Advent"), one of the largest and most experienced global private equity investors, announced today that it has agreed to acquire IPH, a European industrial supplies distributor, from PAI Partners, a leading European private equity firm. IPH distributes industrial supplies for maintenance and production applications in Europe. It offers power transmission products, machining solutions, industrial supply solutions and product-related services. IPH serves a range of industries, including

heavy industry, chemical and pharmaceutical, food-processing, energy, transport, automotive, petrochemicals, and mechanical engineering industries. In 2016, IPH generated revenues of €1.3 billion.

Advent, which took private Brammer Limited ("Brammer") from the London Stock Exchange earlier this year, intends to combine IPH with Brammer, to create a leading European distributor of industrial supplies, with over €2.1 billion in revenues. The complementary geographic coverage, product knowledge, and breadth of offering will further strengthen the value proposition for customers and suppliers.

Shonnel Malani, Managing Director, Advent International, said, “We are pleased to undertake a positive strategic step in the industry by bringing together two leading companies – Brammer and IPH – and are committed to investing in their combined success.”

Nicolas Holzman, partner at PAI, said, “During our investment period, IPH has transformed into a leading pan European platform. Since 2013, IPH has concluded more than 50 acquisitions with the entry in 5 new countries and an improved product offering. These achievements have enabled IPH to double in size. We wish now all possible success to IPH, Brammer and Advent.”

Pierre Pouletty, Chief Executive Officer, Groupe IPH, added, “We at IPH are very pleased to join with

Brammer, and with the support of Advent, commence an exciting new chapter for our growth. As allied companies, IPH and Brammer will offer customers and suppliers great benefits from the enhanced value proposition our combined businesses.”

Hermann Maier, Chief Executive Officer, Brammer, added, “This marks an important step for Brammer. I have no doubt the combination with IPH will help us become an even better distribution partner and employer. As a combined group we are now able to move forward from a position of great strength.”

The transaction is subject to antitrust and regulatory clearance.

June

13

Schaeffler appoints Maxim Shakhov as “CEO Russia”



Maxim Shakhov has assumed the position of “CEO Russia” for the Schaeffler Group on June 13, 2017 and will be based in Moscow. Maxim Shakhov (50) has assumed the position of “CEO Russia” for the Schaeffler Group on June 13, 2017 and will be based in Moscow. In this function, he will report directly to Prof. Dr. Rainer Lindner, CEO of Central & Eastern Europe and Middle East & Africa.

Following a successful career at DuPont and Vaillant in Germany and Russia, Mr. Shakhov took over as CEO at the Bionovatic Group, a Russian start-up

company which specializes in biotechnology, in 2016. With an engineering degree, an MBA, and many years of experience on the Russian and German markets, he meets all the requirements to further develop the Schaeffler Group for the future in Russia.

After moving its offices into the House of German Industry in the center of Moscow, and after having established strategic customer contacts, Schaeffler has continued to consistently implement the strategy to strengthen its position on the Russian market and develop new market opportunities by appointing a CEO Russia.

June

28

New Antidumping Petition on Tapered Roller Bearings from South Korea

The Timken Company (Timken), on June 28, 2017, filed an antidumping (AD) petition on certain tapered roller bearings from South Korea.

The U.S. AD law imposes special tariffs to counteract imports that are sold in the United States at less than “normal value.” For AD duties to be imposed, the U.S. government must determine not only that dumping is occurring, but also that there is “material injury” (or

threat thereof) by reason of the dumped imports.

Importers are liable for any potential AD duties imposed. In addition, these investigations could impact purchasers by increasing prices and/or decreasing supply of tapered roller bearings.

Scope

The scope of this investigation is certain tapered roller bearings. The scope covers all tapered roller bearings with a nominal outside cup diameter of eight inches and under, regardless of type of steel, whether of inch or metric size, and whether made of through-hardened steel or case hardened (case-carburized) steel. Certain tapered roller bearings include: finished cup and cone assemblies entering as a set, finished cone assemblies entering separately, and finished parts (cups, cones, and tapered rollers). Certain tapered roller bearings are sold individually as sets (cup and cone assembly), as a cone assembly, as a finished cup, or packaged as a kit with one or several tapered roller bearings, a seal, and grease. The scope of the petition includes finished rollers and finished cones that have not been assembled with rollers and a cage. Certain tapered roller bearings can be a single row or multiple rows (e.g., two- or four-row), and a cup can handle a single cone assembly or multiple cone assemblies. Included in the scope are thrust bearings. The scope of this investigation does not include unfinished parts of tapered roller bearings (cups, cones, and tapered rollers) and does not include cages, whether finished or unfinished. The scope does not include tapered roller bearing wheel hub units, rail bearings, and other housed tapered roller bearings (flange, take up cartridges, and hanger units incorporating tapered rollers). Tapered roller bearings that have a nominal outer cup diameter of eight inches and under that are used in wheel hub units, rail bearings, or other housed bearings, but entered separately, are included in the scope to the same extent as described above. All tapered roller bearings meeting the written description above are included, regardless of coating.

Tapered roller bearings subject to this investigation are primarily classifiable under subheadings 8482.20.0040, 8482.20.0061, 8482.20.0070, 8482.20.0081, 8482.91.0050, 8482.99.1550, and 8482.99.1580 of the Harmonized Tariff Schedule of the United States ("HTSUS"). Parts may also enter under 8482.99.4500. While the HTSUS subheadings are provided for convenience and for customs purposes, the written description of the subject merchandise is dispositive.

Alleged Dumping Margins

Timken alleges dumping margins exist ranging up to 143.3 percent.

Estimated Schedule of Investigations

June 28, 2017 – Petition is filed
July 18, 2017 – DOC initiates investigation

July 19, 2017 – ITC staff conference (estimated)

August 14, 2017 – Deadline for ITC preliminary injury determination

December 5, 2017 – Deadline for DOC preliminary AD determination, if deadline not postponed

January 24, 2018 – Deadline for DOC preliminary AD determination, if deadline fully postponed

June 8, 2018 – Deadline for DOC final AD determinations, if both preliminary and final AD determinations are fully postponed

July 23, 2018 – Deadline for ITC final injury determination, assuming fully postponed DOC deadlines

By Douglas J. Heffner & Richard P. Ferrin



TOP TOOLS ARE HALF THE JOB

Bega Special Tools is manufacturer and distributor of BETEX Tools for safe and cost-effective solutions for mounting and dismounting of bearings and drive components in MRO and OEM companies in maintenance and production.

Our motto: use the right tools, work safe and efficient.

- ✓ No damage to parts
- ✓ No waste of valuable time
- ✓ Safety first
- ✓ Tailored to your specific needs



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A WORLD OF LINEAR BEARINGS

Miniature linear guides bring higher dynamics to pick-and-place machines



Assembly machines in the semiconductor industry put high demands on pick-and-place units. (Photo: Arijit Modal/ Shutterstock)

As machines for the semiconductor industry operate with cycle times of one second or less, pick-and-place units must offer very high dynamic performance. A case in point can be seen at a manufacturer of chip-mounting systems, where NSK recommended a combination of its ball screw and miniature linear guide technologies to replace the existing linear motor and significantly increase dynamic capability.

With regard to the process, the pick-and-place unit of the assembly machine grips a semiconductor chip and inserts it inside a package. During this operation, the facilitating 40 mm stroke is executed at a speed of 2.5 m/sec.

The linear motor used previously was performing this task at the limit of its capability, which prompted the OEM to approach NSK for an alternative solution. After a comprehensive assessment of the application, NSK's engineers proposed the use of a BSS Series ball screw in combination with PU Series miniature linear guides.

NSK's PU miniature linear guides are purpose-designed for demanding applications such as those found in semiconductor manufacturing equipment and medical devices. Smooth ball recirculation enables effortless motion, while an enhanced seal prevents friction dust from entering the surrounding environment. This makes PU miniature linear guides suitable for use in clean room applications with an appropriate lubricant.

Another advantage of the PU Series is low weight: the carriage is approximately 20% lighter than comparable systems on the market, which makes a considerable difference in highly dynamic applications. The drive unit of the pick-and-place system now weighs only 1 kg, while its operating speed is 2.5 m/s (with an acceleration of 40 g). In addition, it offers a 40 mm stroke and a maximum ball screw rotational speed of 5000 rpm.

Thanks to this high-performance capability, the NSK solution delivers much higher dynamics than the linear motor it replaced. Furthermore, the manufacturer



The NSK PU Series of miniature linear guides was developed for demanding applications such as semiconductor manufacturing equipment.



NSK's BSS Series ball screws ensure exact positioning with short cycle times

of the chip mounting systems says it is fully satisfied with the reliability and lifespan of the PU Series miniature linear guide and BSS Series ball screw.

Ten times more service life for linear guides in robotic welding applications

A manufacturer of sheet metal assemblies recently sought a solution to short lifespan issues with the drive and guide elements on its automated welding systems. In fact, the linear guides for a robotic welding gun on one particular production line had to be replaced every two or three months. Due to the cost of replacement parts and maintenance time, as well as equipment



Linear guides in robotic welding systems are subject to harsh operating conditions

downtime, the company asked NSK to investigate and provide a proposal to address the problem.

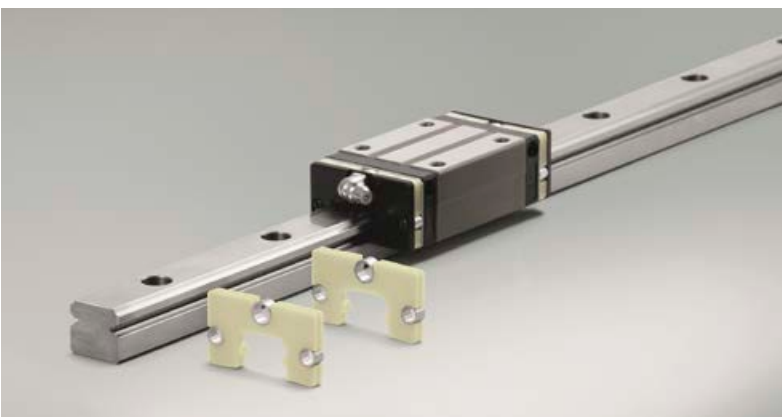
NSK discovered that weld spatter and fumes were adversely impacting the operating life of the guide elements. The company therefore suggested replacing the existing guides with its NH series linear guides in combination with protectors and K1 maintenance-free lubrication units.

Capable of providing long-lifetime performance in automated welding

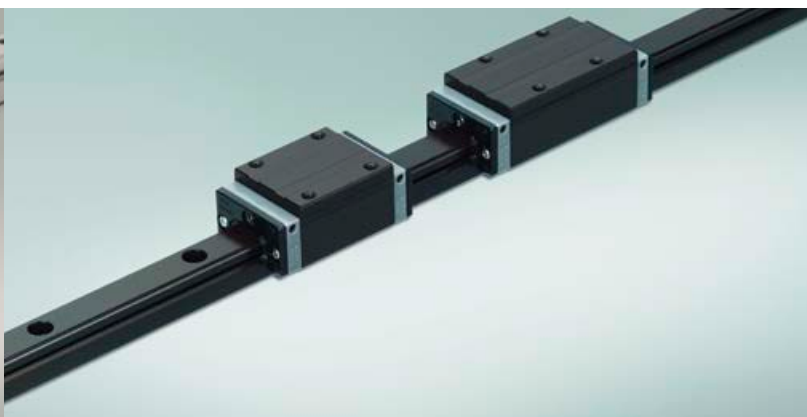
applications, the protectors effectively shield the sealing lip and prevent contamination from reaching the guide interior. An effect of the use of protectors is increased contact pressure between the rail surface and the seal. In this application, NSK also recommended the use of its K1 lubrication units, which allow the sealing lip to move at low friction over a film of oil. The K1 comprises a synthetic base material that holds the lubricant in its pores and extrudes it continuously, thus delivering maintenance-free operation.

For additional protection, the surfaces of the linear guides were plated with black chrome to prevent the permanent adhesion of weld spatter. Spatter adheres only lightly to the plated surfaces and gets dislodged when contact is made with a protector.

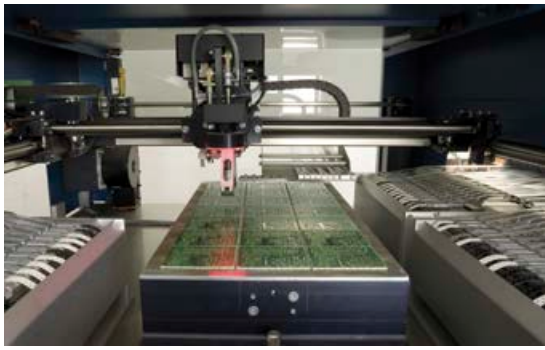
NSK's NH series linear guide solution has solved the customer's problem to its complete satisfaction. The C-type weld guns have been in operation for over three years without any failures. To date, this means that service life has been



NSK's K1 lubrication units and protectors significantly increase the service life of linear guides



Black chrome plating helps prevent weld spatter from becoming permanently attached to the linear guides



A typical SMT placement machine in the electronics industry can place more than 50,000 components per hour on PCBs with high precision. This puts heavy demands on the pick and place units. (Photo: iStock.com/thiel_andrzej)

multiplied by a factor of 10.

Linear Guides prove ideal for pick and place machines

Faced with repeated failures of its linear guides, an established and reputable manufacturer of surface mount technology (SMT) pick and place machines turned to NSK for the solution. After identifying the source of the problem, NSK was able to recommend its NH Linear Guide series. Today, several thousand such units have since been supplied to the customer, with no premature failures reported.

The pick and place units deployed in SMT assembly machines must withstand high mechanical stresses. A typical machine operating in the electronics sector is able to place components on printed circuit boards at speeds of more than 50,000 components per hour, with high precision. Furthermore, these machines can handle components from up to 200 feeders (rolls of electronic parts) simultaneously.

With so many electronic components being placed so quickly, it is inevitable that problems sometimes occur. This was the case with the pick and place system on a new series of SMT assembly machines being developed by a European OEM. The manufacturer experienced a very short lifespan from its original linear guides, while replacing them with others from a second manufacturer yielded no improvement. What's more, neither supplier could find the cause of the failures or offer a solution.

Following these disappointments, the OEM contacted NSK, which tasked a team

of experts with analysing the failed components. The conclusion, determined primarily by the damage exhibited on the components, indicated that the moment (tilting) load was too high. The cause of this was attributed to misalignment errors within the pick and place system.

As a result, NSK recommended switching to its NH Linear Guide series, which is not only purpose-designed for high-speed applications, but offers self-aligning capabilities. A special type of grease was also implemented as it could provide better lubrication properties than standard grease in applications featuring short strokes and shock loads.

The project proved highly successful. Once the NAH2oANZ type guides from NSK began to enter service, the OEM experienced no more breakdowns. Moreover, several thousand installations later, the NH Linear Guides are proving to have a long lifespan.



NH-series linear guides from NSK have proven their reliability in this application

NSK's NH/NS Linear Guides win Cho Monozukuri Award

NSK has been presented with the Cho Monozukuri Innovative Parts and Components Award for its NH/NS Series Linear Guides. Established by the Japanese government in 2004, this prestigious award recognises the valuable contribution that manufacturing makes to both industry and society. NSK's NH/NS Linear Guides have double the lifespan of conventional products due to the

inclusion of specially developed features such as a new ball groove. The judges said that the linear guides and the technology behind them earned the award by contributing to longer equipment lifespan and smaller system size.

Applications for NSK Linear Guides include machine tools, robots, laboratory automation, medical imaging equipment, liquid crystal and semiconductor manufacturing equipment, automotive manufacturing systems, factory automation and healthcare equipment to list but a few. The latest NH/NS series offers significant advantages over previous generation linear guides, such as improved productivity and longer maintenance intervals. For instance, up to 1.3 times greater dynamic load rating is provided to help achieve 100% more fatigue life. Dynamic load rating is an index value for evaluating linear guide load bearing performance, with a larger value indicating longer lifespan.

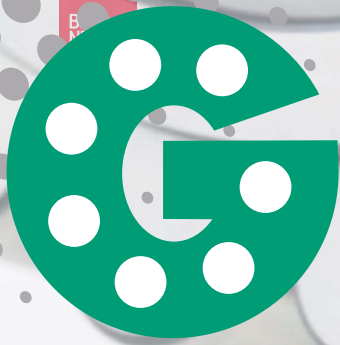


Souichirou Katou (left, General Manager) and Jun Matsumoto (right, Manager) from the LG Technology Department at NSK's Linear Technology Centre in Japan display the Cho Monozukuri Innovative Parts and Components Award.

Further advantages of NSK's NH/NS Linear Guides include an increase in speed capability of 1.5 to 3 times depending on size, a 3dB noise reduction and improved ease of motion. In addition, the installation dimensions are purpose-designed to be the same as the conventional LH/LS Series, permitting them to be adopted without modifying equipment design. The NH/NS Series also allows a combination of rails and bearings to be used with popular options such as the NSK K1 lubrication unit for long-term, maintenance-free operation.

NOVA/TCB provides custom bearings specifically designed and manufactured to the customer's print specifications and requirements,

as well as a variety of common bearings and components for the high volume after-market industry.



SCHAEFFLER



FAG



The Godiva Bearings and INA partnership started over 30 years ago and in that time, we have grown to be one of the largest Stockists of INA in the World.

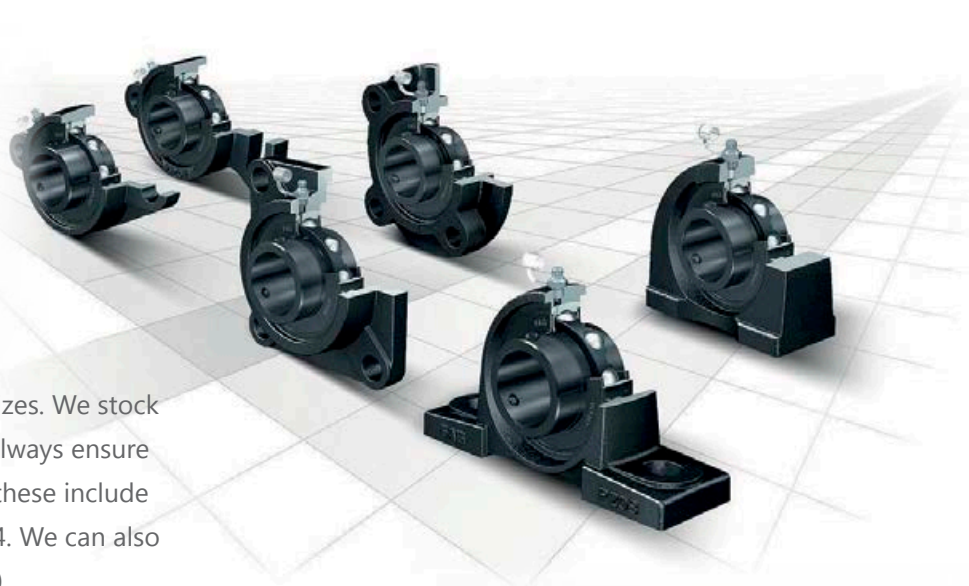
In 2005, the FAG brand joined the INA brand in what was a massive step within the Bearing Industry. The prestigious Schaeffler Group are leading Global manufacturers of outstanding and technologically engineered products designed for the automotive and industrial market. Constantly building on their product innovation enables Godiva Bearings to offer the UK an extensive range of quality Bearings.

What's new? Godiva Bearings now stock the full range of FAG Black Series Pillow Blocks. The innovative Black Series boosts decreasing product lifecycle costs, shorter production downtime and improving maintenance systems. We hold both metric and imperial sizes in our main warehouse in the West Midlands for Same-day collection or dispatch, delivered with instantly recognisable single-boxed FAG packaging, which creates a great visual impact too!

Did you know... Our warehouse holds quantities of the full range of INA Needle Roller Bearings in abundance. Our Superhero expertise extends to all types of applications, in both metric and imperial. In fact, our experience and knowledge with INA Needle Bearings simply cannot be beaten. Whether it be an HK or a large SL Bearing, we have them all and everything in between!

We hold the smallest to the largest sizes, even including the eccentric versions of INA Cam-Followers which are used all over the World and in various types of applications.





FAG Ball Bearings cover an enormous range of sizes. We stock in-depth the ever popular metric series but we always ensure larger types are available to our customers too; these include the ZZ and 2RS versions as well as C2, C3 and C4. We can also supply these with special Lubricants (on request).

Our stock of FAG Cylindrical Roller Bearings are predominantly used in heavier duty applications, from high speed, high quality gearboxes to the quarry and mining industries - we have the full range available. We also supply and stock Cage versions such as plastic, steel and brass.



What can we offer? Our very experienced Sales force are able to offer you help with identifying your Bearing and can offer full technical back up; on occasions, we can even organise an engineer visit your customer. Being Trade-Only means we only supply to the Trade and your customers always remain your customers.

We are the Bearing Superheroes ready to support and assist you in meeting your customers' needs. If you need to find a particular size, have an urgent query or require technical support, contact us today on either our Dudley Sales Line: 0845 345 5955 or Newcastle Sales Line: 0845 345 5920.



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INNOVATING DESIGN FOR AN EFFICIENT BUILD

How Innovative Solutions Improve Vehicle Fuel Efficiency and Optimise Productivity for Automotive System Suppliers

by Mirko Hundertmark, Global Market Manager, Automotive Interior, Hans-Jürgen Jäger, Global Market Manager, Automotive Exterior and Chris Needes, Global Market Manager, Automotive Chassis and Powertrain, NORGLIDE® Bearings and RENCOL® Tolerance Rings.



Today's automotive manufacturers must meet a number of demands from consumers and regulators while staying cost competitive. While vehicles are produced at faster rates, automakers must continue to balance increased efficiency with quality and innovation and find ways to enhance productivity throughout the entire supply chain.

In terms of regulations, manufacturers and system suppliers worldwide have to comply with government legislation demanding carbon emission reductions. The US Environmental Protection Agency (EPA) require automotive companies to average carbon dioxide (CO₂) tailpipe emissions at 101 grams per kilometre by model year 2025. The European

Commission regulations, in effect from 2012, levy a fine of 20 Euros on manufacturers for every gram of carbon dioxide (CO₂) emitted over the limit of 130 grams per kilometre for all cars across their entire fleet. In 2015, the fine is expected to reach 95 Euros per gram. China has taken steps to introduce its National Standard IV legislation, based on CO₂ reduction regulations already in effect in Europe. Reducing vehicle weight is one of the means to improve fuel efficiency. According to the EPA estimations, every 10 per cent drop in car mass decreases fuel use between 5 and 10 per cent.

When aiming to reduce vehicle weight and size without jeopardising productivity, it is often the small parts that can make a big difference. By evaluating the options

available in the marketplace for each particular application, system suppliers can select the correct components to be successful, while maximising the performance of each mechanism in the car. Specifically, we can evaluate how selecting the right composite bearings and tolerance rings can optimise steering, exterior and interior automotive applications, resulting in more fuel-efficient automobiles and minimised manufacturing costs.

Improving the Performance of EPAS motors

One such application that can be improved significantly through the selection of the ideal components is the Electric Power Assisted Steering (EPAS) motor. By selecting the right solution to fix the EPAS motor to the steering system, manufacturers can enhance the assembly process, allowing weight and space savings while lowering bottom line manufacturing costs. In this application, a tolerance ring can be used to hold the motor over a thermal cycle from the engine heat and create a joint stiff enough to dampen noise and vibrations.

Tolerance rings are high-quality, radially sprung fasteners that allow for an optimal joint between mating components. With

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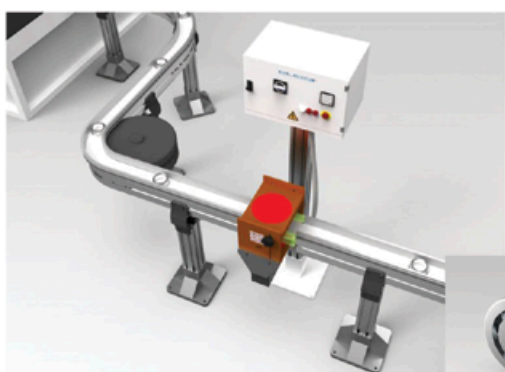
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During the manufacturing process, the demagnetization, as magnetic pre-washing, is the optimal preparation for the bearing components cleanliness.

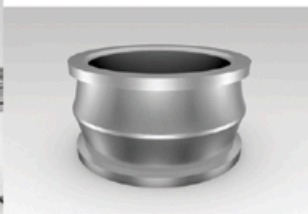
Bussi Demagnetizers prevent from friction, limited fluency, early wear and reduced life of the bearings.



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REPEATABILITY
- EASY PARTS TRANSFER WITH NO
MAGNETIC RETENTION
- EASY IN PROCESS INTEGRATION
WITH I/O INTERFACE
- STANDARD A DEDICATED
SOLUTION DESIGN
- HIGHLY DURABLE INVESTMENT





their wave-like protrusions, tolerance rings compensate for thermal expansion within EPAS motors to allow for a perfect fit between components. This allows the use of dissimilar and lighter weight materials (such as steel and aluminium) in their mechanisms, contributing to overall weight reduction of the steering system and enhancing the fuel efficiency and the smart design of the car. By replacing the cumbersome heat-to-press fitting method used to insert the stator and ensure a tight fit between the stator and the housing, tolerance rings save time and reduce assembly costs.

The heat-to-press method does not provide this thermal compensation, causing looseness, damage or rattle. In addition, it requires high assembly force and precise machining operations to ensure a tight fit, whereas tolerance rings are simply press fit for a shorter production cycle.

Optimising Tailgates

Suppliers of automated closing tailgates, currently found on premium vehicles, can make use of tolerance rings to reduce

mechanism weight. Upon operation, if there is an obstruction interfering with the tailgate closing correctly, the tolerance ring is designed to slip at a certain level of torque, protecting the hinge, gearbox and drive mechanism from damage. Sensors in the system then

intervene to reverse the motion of the tailgate so that the driver can clear the obstruction. The benefits of the tolerance ring allow system suppliers to eliminate previously heavy and bulky clutches from the mechanisms and reduce the number of components used, engineering



smartly designed solutions that save space and weight in the produced cars.

Reducing Machining of Collapsible Steering Columns and Seat Frames

Another example of how car makers can simplify the assembly process is by replacing a plastic sleeve or spring clip in the collapsible steering column with a tolerance ring. Allowing for tolerance compensation, the tolerance rings enable car manufacturers to eliminate secondary machining operations and speed up the production process, creating time and cost savings.

In car seat frame applications, current solutions including Dry Universal (DU) bearings and plastic bearings also do not provide optimal tolerance compensation levels and require precise machining of mating parts, which increase manufacturing costs for system suppliers. An innovative composite bearing with a PTFE liner allows for larger tolerance compensation, reducing machining requirements and enhancing manufacturing efficiency.

Greener Choice

System suppliers are able to significantly simplify their assembly processes by replacing traditional component solutions with composite bearings and tolerance rings offering relaxed tolerances and a perfect fit. These innovative components allow system suppliers to enhance the smart design of their mechanisms through reduced weight and space, translating into lower CO₂ emissions and more fuel-efficient cars.

About the authors

Chris Needes – Global Market Manager Automotive Chassis and Powertrain, Saint-Gobain (NORGLIDE® and RENCOL® products)
Chris develops global business strategies and designs new applications, marketing materials and training materials. He is an expert in process benchmarking, project management, application development, costing, materials and material forming processes.

Chris began his career in 1987 working as an Automotive Product Technologist for British Steel. He has been working for the RENCOL® brand since 2000, with previous roles including Technical Project Manager and Product Manager.

Chris holds a degree in Materials Engineering.

Mirko Hundertmark – Global Market Manager Automotive Interior, Saint-Gobain (NORGLIDE® and RENCOL® products)

Mirko has extensive experience in engineering, sales, marketing and project management.

He joined Saint-Gobain in 1999, delivering on his expertise in sales and marketing and engineering with roles including Quality Manager, Sales Statistics & Analysis Manager and Key Account Manager.

Mirko holds a diploma in Business and Administration with a focus on Marketing and Sales Management.

Hans-Jürgen Jäger - Global Market Manager Automotive Exterior, Saint-Gobain (NORGLIDE® and RENCOL® products)

Hans-Jürgen delivers global business strategies and develops new applications, marketing materials and training materials.

He joined Saint-Gobain in 1998 as a Development Engineer for seals, films and diaphragms. In 2000 he took up the role of Product Manager for NORGLIDE® Bearings in Europe, specialising in non-closure systems with an emphasis on powertrain applications. In 2009, Hans-Jürgen became a Team Leader for Application Engineering in Europe and joined Saint-Gobain's facility in Willich, Germany, as Research and Development (R&D) Manager in 2011. Hans-Jürgen holds a diploma in Mechanical Engineering from the RWTH Aachen University in Germany.

About Saint-Gobain

Saint-Gobain designs, manufactures and distributes materials and solutions which are key ingredients in the wellbeing of each of us and the future of all. They can be found everywhere in our living places and our daily life: in buildings, transportation, infrastructure and in many industrial applications. They provide comfort, performance and safety while addressing the challenges of sustainable construction, resource efficiency and climate change. With 2016 sales of € 39.1 billion, Saint-Gobain operates in 67 countries and has more than 170,000 employees.

Saint-Gobain, producer of NORGLIDE® Bearings and RENCOL® Tolerance Rings, provides engineered components to high volume international manufacturers in the automotive, leisure, energy, electronics, industrial, and other markets, through its 15 sites and six R&D centres around the globe. Backed by a heritage of product innovation, technology, advanced materials and market leadership, Saint-Gobain is dedicated to working with customers using its extensive engineering expertise to deliver standard and custom solutions in NORGLIDE® Bearings and RENCOL® Tolerance Rings that meet the most demanding applications. These small parts make a big difference to end product quality and performance, allowing manufacturers to enhance the smart design of their mechanisms by achieving weight and space savings. The unique composition of the engineered components ensures a perfect fit between mating parts compensating for tolerance expansion and simplifying the assembly process. By reducing vibration and harshness, Saint-Gobain's components offer noise free solutions while controlled friction and resistance to wear and temperature guarantee mechanisms' long life.

For more information about Saint-Gobain, visit www.makingabigdifference.com



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THE VITAL ROLE OF LUBRICATION FOR BEARING PERFORMANCE & LIFE

The Role of Bearing Lubricants

Bearing Lubrication plays a vital role in the performance and life of rolling element bearings. The most important task of the lubricant is to separate parts moving relative to one another (balls or rollers and raceways) in order to minimize friction and prevent wear. A lubricant that is designed for specific operating conditions will provide a load bearing wear protective film. The ideal condition is when the friction surfaces are separated by this film. In addition to providing this load bearing film, the lubricant should also allow for the dissipation of frictional heat thus preventing overheating of the bearing and deterioration of the lubricant and provide protection from corrosion, moisture, and the ingress of contaminants.

Lubricants used in rolling element bearings should have the following characteristics:

- Maintains a stable viscosity over a broad range of temperatures
- Good film strength that can support loads
- Stable structure that provides for long service life
- Non-corrosive and compatible with adjacent components
- Provides a barrier against contaminant and moisture, yet does not leak out of the bearing

Types of Bearing Lubricants

Oil: Both petroleum based and synthetic oils are available. Examples of synthetic oils are silicone, diesters, PAO's, and fluorinated compounds. Bearings lubricated with oil will exhibit less start

up and running torque and have higher speed capability. Oils are subject to evaporative losses so their service life in a bearing is less than grease. Miniature and instrument bearings are often only lubricated once for the life of the bearing, making the choice of lubricant critical. Larger bearings are subject to re-lubrication as part of the machinery maintenance cycle. These bearings are often lubricated via oil recirculation systems that are designed into the machinery or equipment. Temperature range, viscosity, evaporative rate are key characteristics to consider when selecting an oil.

Grease: Grease consists of a base oil with a thickener added. These thickeners consist primarily of metal soaps (lithium, sodium, aluminum, and calcium), organic (ureas), or inorganic compounds. While these thickeners greatly influence the characteristics of the grease, the lubricating properties of the grease are attributable to its base oil. In addition, grease can contain additives that improve its performance. Additive types include antioxidant, anticorrosion, anti-wear, fillers, fortifiers, and extreme pressure fortifiers. Temperature range, base oil viscosity, and stiffness or penetration level are key characteristics to consider when selecting a grease. Most greases used in rolling element bearings are NLGI grade 2

Solid Films: These are non-fluid coatings applied to the friction surfaces to prevent wear. They are used in extreme situations where an oil or grease cannot survive and are typically selected as a last resort or option. These include harsh environments such as extreme temperatures, vacuum, or radiation. These coatings include

graphite, MoS₂, silver, gold, or PTFE. Hard coatings include TiC or chrome. Solid films are engineered on a specific application by application basis.

The lubricant (and amount) selected also impacts the maximum operating speed and torque (both starting and running). In miniature bearings the lubricant can impact the noise level. Filtered greases and oils are recommended for use with miniature or instrument bearings.

Bearing Lubrication Methods

Grease is normally applied with special lubricating equipment with a head that deposits the grease between the balls forcing it into, and around, the ball (or roller) raceway interface. Upon rotation the grease is distributed within the bearing. Miniature and instrument series bearings are typically lubricated in a clean room environment.

The amount of grease is typically specified as a percentage, such as 30% fill. The percentage represents the actual grease volume compared to the free internal space within the bearing. In other words, if the internal space in the bearing is completely filled with grease with no voids, it would be 100% full. Manufacturers of bearings have different amounts that they would consider standard. This typically ranges from 20% to 40%. In small or miniature bearings grease fill amounts can be as little as 10%.

Oil is applied by the manufacturer with special equipment as well. The amount is not normally specified. In torque sensitive applications excess oil can be removed via centrifuging. This is more common with miniature or instrument type bearings.

Grease Plating (MGGP) - The MGGP process starts with carefully mixing the candidate grease with a volatile solvent. The consistency of the grease is thinned considerably. This mixture can be controlled to achieve different coating thicknesses. The mixture is then injected into the bearing coating all of the internal surfaces. A dipping process is also used in some cases. The solvent is then baked off at low temperature. This method is often used in torque sensitive applications and lubricant migration associated with oil lubrication is a undesirable.

Shelf Life of Bearing Lubricants

Synthetic oils are inherently stable materials. Generally, they are not expected to oxidize, polymerize or volatilize at room temperature for 10 years or more. Ester oils, where the ester linkage may be subject to a minute degree of hydrolysis in the presence of moisture, could become more acidic if moisture is present. Fluorinated oils and silicones are not likely to be affected by simple aging.

Greases can “age” in more complicated ways. Grease quality could be affected by a change in the gel structure. If the gel contracts, significant oil bleed would be evident and the remaining grease would stiffen. The gel structure may also become softer over a period of time.

The lubricants that are in the bearings supplied by AST Bearings are high quality lubricants. Many of these lubricants are also qualified to military or other specifications. The type and quantity of lubricant is in many cases specified by

the customer, and in those cases where the customer has not made a particular selection, the bearings are lubricated to conform to industry standards.

Shelf life is the period following the lubricant’s manufacture during which it is deemed suitable for use without re-testing its physical characteristics. In addition, the manufacturers state that the shelf life applies only if oils and greases are properly stored in their original, unopened containers.

AST purchases the required lubricants from approved suppliers. Our purchasing documents require a Certificate of Analysis to be supplied with the lubricant, and that 75% of the manufacturer’s shelf life is remaining upon receipt. With respect to the shelf life of any lubricant, AST must rely on the shelf life specifications of that particular lubricant’s manufacturer. In addition, AST has established internal lubricant control procedures that include proper storage of lubricants and applying “use by” dates that are consistent with the lubricant manufacturer’s specifications. AST does not “certify” the shelf life of the bearings we lubricate for the following reasons:

1. We are not the lubricant manufacturer.
2. Once the lubricant has been applied to the bearing, or other device, factors, which AST can neither predict, or control



will govern the lubricant life.

Therefore, the end user should establish their own database or guidelines regarding storage life or functional life of lubricated bearings. AST routinely marks the date of lubrication on our labels and packaging so that customers can apply their internal procedures for age sensitive material.

There are many things to consider when selecting a lubricant such as temperature, loads, speed, environment, and desired life just to name a few. In addition, aside from those already mentioned, there are a variety of characteristics of greases and oils that should be considered such as oil separation, evaporative loss, dropping point, oxidation stability, channeling capability/stiffness, and others. Lubrication is one of the most critical specifications for the designer to consider.

The full of list common bearing lubricants and some of their properties are available AST stocks.



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Tighten the set screws by hand. Tightening the set screws creates extreme holding power over traditional adaptor sleeves without any change to the bearing clearance.



A traditional UK unit requires many tools to be assembled. You must tighten the lock nut using a torque wrench and following a torque tightening chart. Over tightening of the adaptor creates smaller clearance which can affect bearing life.

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