

SHAPING THE MOBILITY FOR TOMORROW
THROUGH INNOVATION BEARING TECHNOLOGY
FOR A SMARTER, CLEANER AND SAFER WORLD

**BEARING
WORLD**

International Bearing Conference

SCHAEFFLER

SKF



Prof. Dr. Tim Hosenfeldt

INNOVATIVE BEARING TECHNOLOGY WILL SHAPE THE MOBILITY FOR TOMORROW

One of the keynote speakers for this year's edition of the international scientific expert conference on bearings was Prof. Dr. Tim Hosenfeldt, Senior Vice President Technology Strategy and Innovation at Schaeffler.

In his keynote, Prof. Dr. Tim Hosenfeldt, explained how global mega trends such as climate change, globalization, urbanization and digitalization affect the corporate strategy and product portfolio of a mobility provider and rolling bearing manufacturer such as Schaeffler.

Most importantly, their effect on the mobility of the future makes it necessary to develop entirely new solutions and products in the rolling bearing industry.

We tried to reveal the essence of his keynote presentation and further the dynamic development in the field of electromobility during an interview.

What is your role in the organization?

I'm responsible for technology strategy and innovation for Schaeffler Group. This means first being responsible for the worldwide advanced research. We have several collaborations, like our Schaeffler Hubs for advanced research in different universities worldwide, where Schaeffler and people work together in shared offices.

Then we have our innovation strategy and roadmap within a perspective of 20 years; with innovation management, new business fields and public private partnership: with one objective in mind: "What need the customer from Schaeffler in the future and how we could be the preferred technology partner?"

Finally, we have a third field where we bring science to business, that's what we

call "Innovation Projects". We go from our knowledge and advanced research to build up for Schaeffler complete new demonstrators, like new wheel hub drive systems that enable new automated mobility concepts, like the "Schaeffler Mover". The department accounts around 90 people at Schaeffler worldwide, distributed between Germany, North America, Greater China, Singapore, and Japan (not including "virtual organizations" coming from universities worldwide). Besides technology strategy and innovation, I'm also responsible for the surface technology field. I'm myself Professor of Surface Technology and Tribology at the university of Erlangen.

Can you tell us more about your key note presentation at the Bearing World conference?

We talked mainly about the mobility of tomorrow: our focus is the need of innovative bearing technologies to make

the world smarter, cleaner and safer. We have disruptive changes coming ahead of us. We actually don't have to decide or discuss; those changes are just coming. The only question is: "How disruptive are those changes?" For that reason, we are well prepared as an integrated automotive and industrial supplier developing to a "supplier of mobility". This is of course a challenging transformation of collaboration and skills. Are we prepared to meet the expectations? Not only what the OEM is ordering from us, but also how look the future of mobility.

Which are the current Global trends on mobility?

We are working on 94 trends at the moment, and 4 "megatrends" can be distinguished among them. The first is the environment, more specifically the climate change. According to the Paris agreement we must limit the temperature increase only of 2°C and to reduce the CO₂

"The fourth mega-trend is technology and digitalization"



Prof. Dr. Tim Hosenfeldt,
*Senior Vice President Technology Strategy
and Innovation at Schaeffler AG*

“The IoT and Industry 4.0 are both aspects of the increasing digitalization and may drive us into more communicative and interactive projects.”

emissions. This is not locally, but globally. Then, we have the society change: more and more people are living in mega-cities (in Europe: Paris and London) and driving or moving every day longer distances in very congested places. Moving to the third change is the globalization: more and more people have increased wealth and have higher standards, including for mobility. This increases the need of efficient mobility in the mega-cities, but also between them. If we discuss more locally for mega-cities, another objective is also to aim for emission-free solutions. Current diesel engines are relatively successful at reducing emissions but there's still work to do regarding particles.

The fourth mega-trend is technology and digitalization. It influences nearly everything, as a threat but also as a big opportunity. The key message for Schaeffler as technology leader is: anything that could be electrified, connected and automated, will be in the future. This brings the topic of e-mobility, especially for mega-cities, and energy efficiency: lightweight, low-friction, low-noise bearing solutions. And finally, the Internet of Things will connect machines with people. This means that the bearings should get new functionalities, like collecting data related to mobility. From that point of view the bearing is the ideal machine

element since you have motion, forces, torque present in the same component.

How do you see the correlation between IoT and Industry 4.0?

This is an important topic. For me, the IoT and Industry 4.0 are both aspects of the increasing digitalization and may drive us into more communicative and interactive projects. The key for Schaeffler is to make smarter products to collect data, allowing simultaneously stronger consumer-supplier impact off automated real-time processes. Of course, we will have to build knowledge from that data. Therefore we have a digital agenda running based on 5 key elements: product & services, machines, processes, analyses & simulations, and finally user experience. For this last part, the goal is to generate value for our customers but also for the people of the factories. To summarize, IoT and Industry 4.0 are great support to handle the growing complexity.

Can you share with us Schaeffler's “Mobility for Tomorrow” strategy focus areas?

This is where our corporate innovation management find its best role: looking how is the world changing and focusing on the four megatrends (as previously evoked). Practically, we've created four focus areas that we are currently

working on at Schaeffler: eco-friendly drives (optimized combustion engines, electric drives, industrial drives), urban mobility (two wheelers, inner-city railway, micro mobiles), interurban mobility (rail vehicles, aircraft, off-highway) and energy chain (wind power, solar power and conventional power generation). The strategy is to deliver the right components and systems to address those focus areas. Moreover, we have now new business unit completely focusing on e-mobility and Industry 4.0.

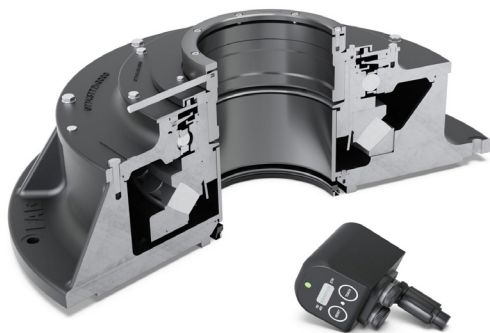
How is Schaeffler as a global automotive and industrial supplier pushing ahead with its transformation process in readiness for the future?

It is doing this by means of “Agenda 4 plus One”, our program for the future. The program is structured into four plus one categories: “Customer focus”, “Operational excellence”, “Financial flexibility”, “Leadership and talent management”, and – as the “plus One” – “Securing long-term competitiveness and value creation”.

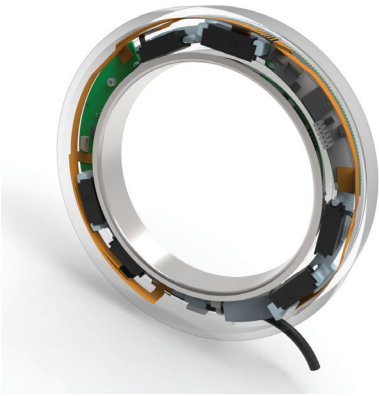
It is broad-based and encompasses 20 initiatives, including E-Mobility, Industry 4.0 and our Digital Agenda. ‘Agenda 4 plus One’ is the driving force behind our transformation.

What is the role of bearings for Industry 4.0 and eMobility?

A big challenge for Schaeffler is the ambidexterity in the field. On one hand, we have to produce better and better bearings in term of lifetime, endurance, tribology and energy efficiency. On the other hand, bearings are fitted everywhere in the mechanical processes and they are



—Flanged housing units with for electric motors



— Schaeffler integrates sensor technology into its spindle bearings

therefore predestined for data collection in terms of process-control and machine monitoring, would it be a machine for production or just a driving application. For example, in our e-wheel drive there's a complete digitized drive-train in the rear. In that sense, Schaeffler develops sensorized components and mechatronic products. These are, according to me, formidable enablers for Industry 4.0

What can you say about the quote “The bearing of the future will be an integrated sensor”?

The bearing is the sensor, or the sensor is an integrated bearing : collecting the data where “the data occur”. The pre-processing is made by Schaeffler and transmitted to the Schaeffler-Cloud allowing further analysis to support our customers with not only data, but also knowledge.

Can you give us some examples of Schaeffler’s sensorized components and mechatronic

“The bearing is the sensor, or the sensor is an integrated bearing : collecting the data where the data occur.”

products which play an important role for Industry 4.0?

I'd like to start first with our vision and base eco-system. We are today able to offer standard hardware solutions and IT infrastructure as well, from simple components to complete digital services. It encompasses all stages of the digital added value. In parallel, we've put efforts to build an open, flexible, extendable and application-oriented architecture to allow users to benefit from all the strategic services of Schaeffler. On top of it, via Cloud, we help the customers to control processes, maximize availability and optimize product quality.

Coming to the products, Schaeffler developed the “VarioSense” sensor-bearing: this is a standard bearing combined to an integrated modular sensing system to measure speed, shaft displacement, vibration or temperature, depending on what the customer actually need to measure. It can be used in various applications like for example gearboxes, pumps but also e-motors.

The second solution we offer is build based on a holistic approach for linear guidance systems in machine-tool and handling systems. We call it “DuraSense” : it combines monitoring of the lubrication condition and automatic

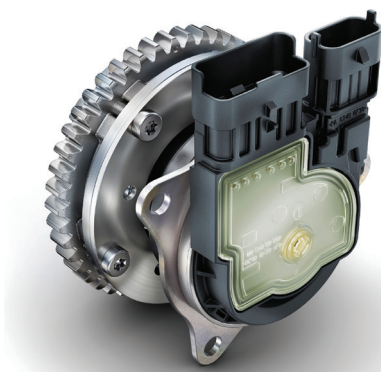
re-lubrication of the guidance. The customers can, that way, avoid unplanned downtime and reach longer lifetime.

A newer sensorized product we offer is called “TorqueSense”: it's a plug-and-play sensor unit for Off-Road powertrain applications. We enable direct measuring of the torque and the torque distribution using contactless and very robust physical principles.

Besides those specific, we have general solutions for condition monitoring, like our SmartCheck solution. The customer can directly mount it on most of applications like gearboxes, pumps or e-motors, to measure vibration, speed and temperature. Benefits for customers are clear: avoid unplanned breakdowns and support predictive maintenance operations. Schaeffler is able to equip existing solutions, new integrated solutions, as well as retrofitted applications.

How important will “coatings” be in eMobility?

In every tribological system, you have what you could call two “surface-partners” and -most of the time- a lubricant. So in terms of energy efficiency, it's obviously very important



— Urban vehicle concept for the future: “technologies for the mobility of tomorrow” powered by innovative wheel modules

Smart hybrid transmissions

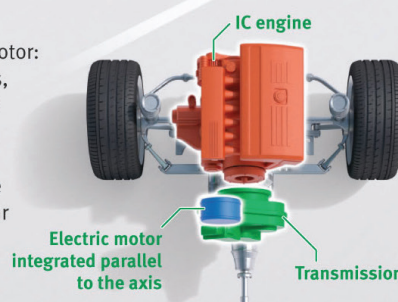
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Schaeffler has developed a space-optimized transmission for plug-in hybrid vehicles. The **dedicated hybrid transmission** combines the benefits of an automated manual transmission with those of the electrified powertrain. At the same time, driving dynamics and ride comfort are enhanced while consumption and emissions are reduced.



Functional principle: DH-ST 6+2

One total transmission system for the IC engine and the electric motor: Its special feature is a division of the transmission into two units, each with two gear ratios. Located between them is a replication transmission, also with two gear ratios. The IC engine uses both transmission units including the one of the electrical path. As a result, six gears in total are available to the IC engine. Due to the dual use of one gear level, five gear wheel levels are sufficient for this purpose. Two gears are available to the electric motor.



Benefits of the transmission architecture



High power output



Small space



Cost-efficient



Reduced consumption

During shifting events the integrated electric motor compensates for the absent torque of the IC engine. The compact design of the mechanically sophisticated transmission saves valuable space. Six gear ratios in ICE mode and two in electric mode ensure particularly low consumption. The dedicated hybrid transmission is ideally suited for vehicle concepts with high overall system output.

Graphic: www.josekdesign.de

— Schaeffler is accelerating electric mobility

to reduce first the friction losses.

Therefore we developed a comprehensive “coating-toolbox” focusing on the most important criteria’s: friction reduction for higher energy efficiency increased lifetime by wear and corrosion protection. Smart surfaces by sensorical coatings. Another important field is the electrical insulation (which is a growing field in the e-mobility): to avoid electrical current between the metallic parts and damages to the oil. Surface Technology addresses those matters to propose more efficient products. A better control of friction losses allows you to drive longer distances with or the same battery capacity.

Do you also develop new technologies for energy efficiency?

Like mentioned previously, everything where you have sliding contacts and/or friction is an important topic. On the other hand, we also tackle this challenge with “Lightweight” designs. The goal is to use

new composite materials or multi-material concepts: using the right material at the right place. And finally, at the stage of exploration, we work on bearings where there’s only air between the two surface-partner, avoiding thus any contact.

How will all these new developments affect the TCO for customers?

Total cost of ownership is a very important aspect, especially if you look into the B2C market. The customer doesn’t necessarily pay for the product, but also for the use. Traditionally, we sell a bearing and the business is done. But more and more, the customer orders availability or productivity. For example in the railway segment, we are responsible to deliver availability or miles, and we support it with whole predictive maintenance solutions to keep the applications running.

This is what the customer pays for. If

we come back on mobility, it will be more and more connected, automated, emission-free but also more and more shared. TCO-wise, people will want more and more to buy mobility instead of owning their mobility device. We can also imagine in the near future apps telling you automatically what devices to use to get from a point A to B. So yes, TCO will be more and more important in the future.

What is the purpose of “Multi-Material Concepts” and “bionic design”?

The Multi-Material Concept is how we enable optimal utilization of the material properties, and adapt the material selection locally to the product requirements. One technology that perfectly allows us the local use of different materials is additive manufacturing. Indeed, the additive manufacturing enables the next step of coating: this is the coating “in three dimensions”. That way, we can have

a quite intelligent material design and obtain the properties we exactly need. Therefore, developing traditional manufacturing with the new techniques is very important. Schaeffler is very strong regarding that aspect. We are not only experts in materials and surface technology research, but also in producing the best quality and delivering high quantities at the same time. In Aerospace for example, we have already developed solutions with special cooling features and integrated sensors. This is a great field for additive manufacturing development, but not the main market.

About the bionic designs, nature was a great inspiration. If you observe nature, for example how a tree is growing, material is used in an ideal manner only where it is needed. This inspiration can be used in technology, and this what I've showed in my presentation during the conference: bearings can be designed and manufactured from steel, multi-material plastics and plastic-metal hybrid design to reduce the mass by more than 20% and have the same lifetime or

endurance. Better friction properties can also be obtained by putting a composite material in place of pure steel-to-steel counterparts, and only where it's needed. Finally, a significant cost reduction can be reached by building this optimized design in comparison with a whole component.

As conclusion; what are still the main challenges for a successful "Mobility for Tomorrow"?

The challenge lies in the ever-increasing complexity, more fractured mobility, the different demands, additional competences and also the different perceptions depending on the regions of the world. An important key to success is the capability for system based thinking and ambidexterity, the rare ability to use both hands at the time with equal skill. This means continuously perfecting proven products and at the same time developing new sectors and applications. This entails major changes in the variety of necessary competences and requires an overarching and agile collaboration within the company and across company

boundaries across different industries. If you talk about "urban and micro mobility" solutions in Germany or Europe, it may not necessarily mean the same thing in Singapore, Greater China or Japan. Besides, we face more and more diverse drive-trains, more diverse and more complex vehicle components and even more diverse energy sources. Of course, today if you buy a car, you can do everything with it : driving in the city or inter-urban. But at the end of the day, we observe that still, people tend to use more and more diverse and specific mobility solutions.

The shared mobility model is also getting more important and we can imagine soon complete automated systems running 24/7, with a higher demand on component's lifetime. Of a course, to achieve this, a robust digital macro-infrastructure is needed an a very intuitive and self-explanatory interface as well. I have to notice that we still don't have at the moment in Germany. We need a broad, safe, complete internet access to achieve all the ambitions of the Internet of Things.

One platform – many possibilities

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The Schaeffler Mover with **wheel-hub drive** provides a flexible and zero-emissions platform for diverse vehicle concepts. All drive and suspension modules are installed in a single unit, the "**Schaeffler Intelligent Corner Module.**" The module is easily scalable in terms of vehicle length and width as well as for maximum space for new cabin concepts.

Maximum maneuverability

The Schaeffler design permits a steering angle of up to 90°. This results in enormous agility of the vehicle and also makes parking maneuvers possible with minimal space requirements.



Steering motor with transmission

Yoke

Spring and dampers

Wheel-hub drive

Intelligent Corner Module

Variable vehicle concepts

The vehicle's platform, the "Rolling Chassis," houses the entire drive technology. Various body versions for passenger and cargo transportation can be installed on top of this platform without any modifications of the drive system and suspension.



various body versions

"Rolling-Chassis"