Intellectual Capital -Strengthening Technological Capabilities-

NSK's Four Core Technologies + Manufacturing Engineering

NSK has relentlessly pursued innovative technologies and focused on improving quality to contribute to a safer, smoother society and to protect the global environment, in line with its corporate philosophy. NSK leads the world in the product fields of bearings, automotive components, and precision machinery and parts. Its technological foundation consists of tribology, materials, numerical simulation, and mechatronics, which are NSK's Four Core Technologies, and manufacturing engineering, which gives them shape. Our goal is to be a company that is needed, trusted, and relied upon by society. To this end, we will continue to contribute to the creation of a sustainable and more prosperous society and protect the global environment by saving energy and reducing CO_2 emissions while creating and supplying high-performance and highly functional products to the market in a timely manner.

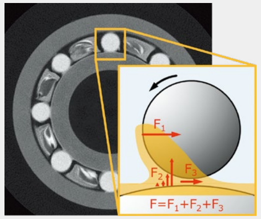
Four Core Technologies + 1

FOUR Core Technologies

Studying, Clarifying, and Controlling Friction

Tribology

Tribology is the study of friction and wear of contact surfaces in relative motion, such as rotating parts that endure enormous forces with a thin oil film. Severe operating conditions are mitigated through lubrication and surface treatments, resulting in superior performance for applications requiring low friction, high-speed rotation, quiet operation, or enhanced durability.

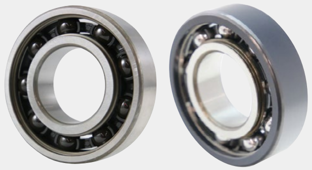


Friction on the bearing's ball surface

Unrelenting Pursuit of Performance Durability and Reliability

Materials

Materials research and development affects nearly every aspect of product performance. We are constantly pursuing cost and productivity while meeting ever evolving demands for improved functionality, durability, and reliability through technologies that utilize metals, polymers, and ceramics with optimized material composition and heat treatment conditions.

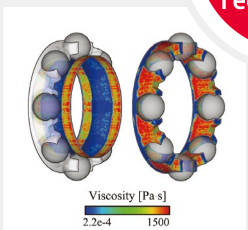


Bearings utilizing ceramics and resins

Reproducing Phenomena in Virtual Space and Predicting Performance

Numerical Simulation

In the past, accuracy and reliability in product development were achieved with experience-based design and longer testing periods. NSK's simulation technology allows virtual validation to accelerate design and production. Extreme conditions or innovative designs that defy previous expectations can also be evaluated and analyzed.



Example of bearing grease flow analysis

Technology That Supports People for a Convenient, Safe, and Comfortable Future

Mechatronics

Mechatronics integrates machine element technology with control technology. By combining bearings, ball screws, and linear guides, together with motors, sensors, and computers, greater mechanical functionality is elicited with computer control. This technology enables new functions and performance in a range of industrial machinery, automotive, and biomedicine applications. It also contributes to greater reliability, as well as to convenience and safety in daily life.

Active Caster

+1

Giving Shape to Four Core Technologies

Manufacturing Engineering

Contributing to the environment and heightening safety and security through our Four Core Technologies requires something to breathe life into these technologies. In addition, it is essential to consistently manufacture products with high quality. NSK tackles these issues by applying smart technology to its equipment, utilizing IoT, and optimizing its overall production framework while it works to realize the creation of smart factories that economize on space, save on energy, and reduce labor requirements.

Cheonan Plant in South Korea

Further Enhancing NSK's Strengths through Open Innovation

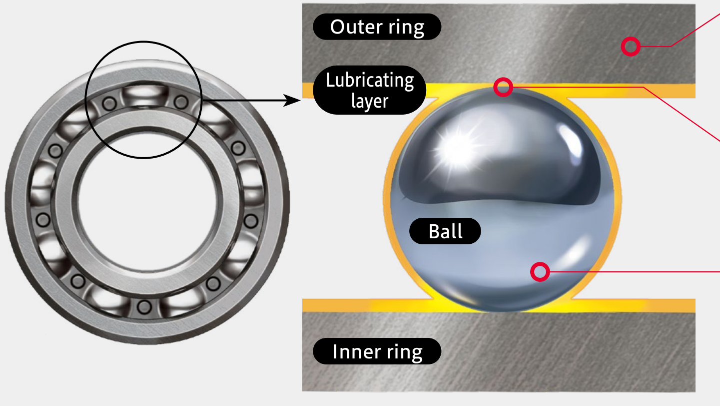
NSK attaches importance to its aim of contributing to the development of a sustainable society and becoming a company that is needed, trusted, and relied upon by society through value creation by combining digital technology with tribology technology, which is one of our "Four Core Technologies Plus One."

The technologies that hold the key to cracking this tribology technology are materials, lubrication, and mechanics technologies. We have been conducting joint research in these three fields with the Tokyo Institute of Technology since 2020. Looking to strengthen their relationship and put in place a system that would enable continued innovative research and development, NSK and the Tokyo Institute of Technology signed an agreement for the establishment of a tribology research center in March 2023.

NSK Tribology Collaborative Research Cluster

In December 2023, the NSK Tribology Collaborative Research Cluster was established at the Tokyo Institute of Technology's Suzukakedai Campus. By conducting research that integrates three fields previously researched separately, the NSK Tribology Collaborative Research Cluster will conduct research in more depth and create groundbreaking solutions that will lead to the creation of bearings and linear motion products with enhanced performance. Through this collaborative research center, researchers from NSK and the Tokyo Institute of Technology will interact closely with each other, and we will continually focus on the development of human resources capable of conducting high-caliber fundamental research.

Three fundamental tribology technologies: materials, lubrication, and mechanics



Materials technology
Identifying the most suitable material texture for each application to help realize reliable, long-lasting products.

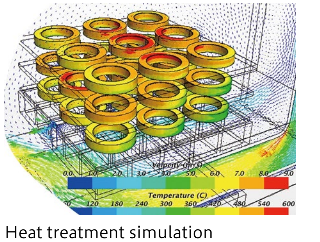
Lubrication technology
Reducing friction by using lubrication to allow bearings to rotate smoothly.

Mechanics technology
Optimizing bearing design and development by understanding the forces acting on the surfaces that are in contact when a bearing spins.

Using NSK Digital Twin to Create Out-of-the-Box Solutions

NSK is committed to NSK Digital Twin, which provides new value to society by maximizing the use of digital technology. NSK Digital Twin is a problem-solving framework focused on enhancing the creativity of engineers and is currently being rolled out to all engineers. NSK Digital Twin digitally reproduces real phenomena, giving a glimpse into their inner workings. It digitally models such mechanisms to give an understanding of the hidden essence of the phenomena. We plan to harness this framework to create out-of-the-box solutions.

NSK Digital Twin is also being used to solve problems with bearings during heat treatment processes. After bearings have been treated in the heat treatment furnace, the cooling process can result in ring deformation, and such deformation needs to be corrected in after process operations. To address this problem, we developed a hypothesis about a deformation mechanism caused by uneven cooling and we digitally modeled the phenomenon inside the heat treatment furnace. By understanding the essence of the phenomenon through repeated insights into the digital and real phenomenon, we were able to implement effective countermeasures and made it possible to realize improved productivity and shorter development times.



Heat treatment simulation