# Intellectual Capital

YouTube video: "THE FUTURE CREATED BY NSK'S TRIBOLOGY TECHNOLOGY"

**The intellectual activities of each and every engineer will be the force that shapes NSK's future, contributing to society through technology with the aim of creating value of which the next generation can be proud.**

**Hayato Omi** Executive Vice President, Head of Technology Development Division HQ

## Focusing on the essence of technology, pioneering the future together with society

NSK's technological development involves taking on challenges that help "make machines operate efficiently and without waste as required" through product improvements and new developments. Our mission is to meet the diverse needs of society through mechanical elements such as bearings and ball screws. Including automobiles, robots, and manufacturing equipment, our range of applications continues to expand, and at the core of our work remains our strong desire to contribute to society through technology.

Social structures continue to undergo a host of changes, including a declining birth rate, an aging population, and climate change. Against this backdrop, electrification, automation, and mechanization are expected to accelerate, making mechanical elements that support moving things indispensable. Their importance and necessity are particularly apparent in automobiles, robots, and in a variety of manufacturing equipment. NSK utilizes its core technologies—tribology, materials, numerical simulation, and mechatronics—plus the manufacturing engineering technologies that give shape to those technologies while pursuing the reduction as well as minimization of friction and energy loss. We believe that by providing highly reliable products, we can contribute to the resolution of social issues on an ongoing basis.

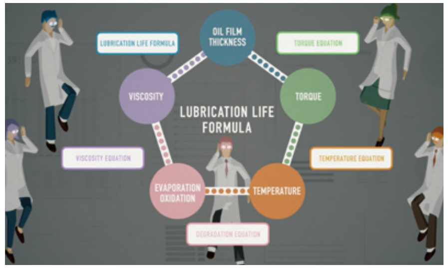
## Bearings & Beyond initiatives

With the aim of pioneering new business domains while maintaining the profitability of existing products, "Bearings & Beyond" is a pillar of NSK's mid- to long-term strategy. To achieve this aim, it is essential that we strengthen our core technologies and expand the breadth and depth of our technologies through open innovation.

Reducing friction loss is an issue that NSK has been working on for many years. Working to push the limits of friction reduction technology through advances in the development of greases and seals, we are making a significant contribution to improving energy efficiency. Not merely improving performance, these technologies also assist in reducing environmental burden, making them an important element in moves toward the realization of a sustainable society. In addition to increasing efficiency, reducing friction extends the service lives of machines, reduces maintenance costs, and leads to heightened product reliability. Scientifically analyzing the mechanisms that generate friction, NSK is pursuing technological development using a multifaceted approach that includes materials, lubrication, and surface treatment.

In the technological development process, open innovation is of the utmost importance. Rather than the Company completing the design of motors and units on its own, the creation of higher-performance more stable products through collaboration with other companies and universities is being demanded. In addition, in the case of mechanical elements such as bearings and screws, initiatives such as N-TRIBO aim to improve design precision by scientifically clarifying the factors that affect bearing life and combining this with digital technology. Under the N-TRIBO initiative, we are conducting research to clarify the five factors that affect the lubricant life of bearings and the causal relationships between each of them. This will enable designs that have a theoretical backing. Breaking away from conventional designs that rely on empirical rules, this kind of approach will realize more reproducible and more sophisticated technological developments.

**Five Factors Affecting Bearing Lubricant Life**




By utilizing digital twin technology, virtual verification is possible even in areas where experiments are beset with difficulties, thereby improving development efficiency and reducing development risks. By clarifying the causal relationships of real-world phenomena and digitally reproducing and predicting them, we can improve design accuracy and efficiency. This marks an important step toward realizing what NSK is aiming for with its "Bearings & Beyond" initiatives.

Technologies such as CMS Glossary and PLM Glossary are also evolving, and "feedforward" control, which utilizes data such as vibration and temperature to predict the future state of machines, is becoming increasingly important. This technology is effective not only for power generation facilities and large plants where failures directly lead to significant losses but also for devices that support the precise operations of robots and automobiles.

Conventional feedback control tends to be reactive, dealing with anomalies only after they occur, but feedforward control makes it possible to detect signs of anomalies in advance and prevent them from occurring. Analyzing a variety of signals emitted by machines, such as vibration, sound, temperature, and transmission efficiency, NSK is advancing technological developments that predict changes in the condition of machines to a high degree of accuracy.

## Our approach to relationships of trust with customers and intellectual property

NSK believes its strength lies in its commitment to providing optimal solutions tailored to customer design requirements. Especially among companies outside Japan, there is a growing trend to promote existing products even when it comes to making design changes for customers, but NSK remains committed to providing optimal solutions by accommodating their design requirements. This is not simply product strength, but part of NSK's intellectual capital—the ability to make proposals based on deep relationships of trust with customers—and symbolizes NSK's technological culture. For example, in the development of ball screws for electric brakes, NSK made it possible to install ball screws, which efficiently convert motor rotation into linear motion, in brake applications by miniaturizing them and increasing their load capacity, thereby creating NSK's proprietary ball recirculation mechanism. Involving closely following customers' design concepts, efforts of this kind offer good examples of NSK's unique technological capabilities.

We also view intellectual property (patents) as the acquisition of rights for technological development, not as a strategic tool, but as the very result of the activities of our engineers. Patents are created in the process of sincerely addressing challenges and finding solutions, and provide the proof that underpins our technological foundation. Rather than pursuing quantity, it is the accumulation of high-quality intellectual property that underpins NSK's technological capabilities. Charting the course of an engineer's thinking, a patent clearly shows the logic behind the three pillars of problem, cause, and solution. Regarding intellectual property not simply as a product but as evidence of the intellectual activities of its engineers, NSK encourages each and every one of its engineers to work with an awareness of intellectual property.

Because NSK's technologies have many aspects where the more you chew, the more flavor they release and the more you can taste them, we will continue to actively disseminate information. Having said this, we hope that our customers and other stakeholders will be kind enough to come and see actual sites and develop a taste for the parts that are difficult to discern from outside.

## Taking on challenges in the Beyond domain and contributing to the future

Even in the Beyond domain, NSK will continue to evolve by incorporating peripheral technologies while firmly maintaining its core competencies. We will also focus on developing compact, highly efficient actuators Glossary to meet the needs of various robots and medical support equipment. While also focusing on complex control technologies such as those used in humanoid robots, NSK will leverage its expertise in the precision and reliability of mechanical elements to address a variety of social challenges. Furthermore, industrial robots are one of the areas where growth is expected to continue in the years to come. Amid calls for designs that operate precisely and consistently, are energy efficient, and can withstand sudden shutdowns, NSK's technologies play a major role.

New value is expected to be created through collaboration between companies, and NSK will give shape to the technologies of the future through collaboration with partners such as CHITOSE Group, which owns a group of bio-venture companies, and Cyfuse, a regenerative medicine venture company. Not limited to mere product development, these efforts are positioned as technological contributions toward the resolving of social issues.

Press release: Notice Concerning Installation of "Chitose Biomass Conversion Plant," Fertilizer Production Plant at ZOOMO, the Morioka City Zoo (Japanese only) ▶

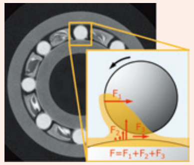
Press release: NSK and Cyfuse Develop New Technology for Automation of Production Processes for Regenerative Medicine ▶

NSK will continue to take on the challenge of realizing a sustainable future while focusing on the true essence of technology and responding flexibly to changes in society. We believe that the intellectual activities of each and every engineer will be the force that shapes NSK's future. We aim to contribute to society through technology and create value of which the next generation can be proud.

### NSK's Core Technologies

Studying, Clarifying, and Controlling Friction

**Tribology**



Friction on the bearing's ball surface

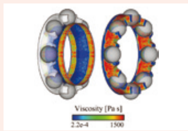
Unrelenting Pursuit of Performance Durability and Reliability

**Materials**

Bearings utilizing ceramics and resins

Reproducing Phenomena in Virtual Space and Predicting Performance

**Numerical simulation**



Example of bearing grease flow analysis

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

**Mechatronics**

Active caster

Giving Shape to Technology

**Manufacturing engineering technologies**

Cheonan Plant in South Korea