

Chapter 2

# Research and Development

## Setting the Future in Motion with R&D

Balancing prosperity with reduction of environmental impact is a challenge in establishing a sustainable society. That is why all manner of things that support society, such as motor vehicles and home appliances, must be made safer and cleaner. R&D is the core driver of this kind of progress. As the world continues to change dynamically, companies are expected to pursue growth in step with the evolution of society by developing more advanced technologies and products.

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## Basic Approach

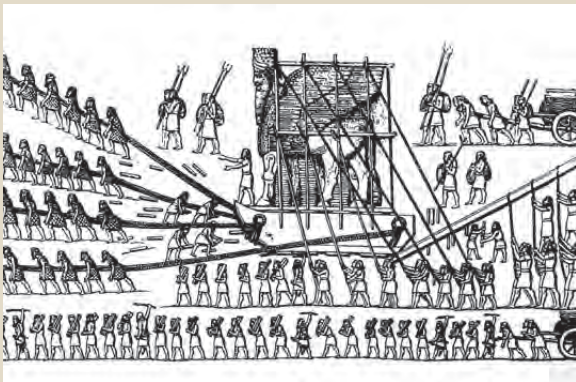
The NSK Group engages in R&D based on its core technologies of tribology (the science of friction and lubrication), materials, numerical simulation, and mechatronics. NSK incorporates cutting-edge expertise and technology into these unique core capacities in order to create further advancement. This process yields original solutions for customers and ensures the timely supply of much-needed new products to the market. This is exactly the type of social contribution called for by NSK's corporate philosophy.

### R&D at NSK: Applying 100 Years of Technology to Set the Future in Motion

For the 100 years since its establishment in 1916, NSK has constantly pursued innovation of technology and enhancement of quality. NSK has grown to become a leading company in bearings, automotive parts, and precision machinery and parts on the foundation of its four core technologies: tribology, materials, numerical simulation, and mechatronics.

#### Tribology

Improving Performance by Optimizing Friction



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 optimized through lubrication and surface treatments developed by NSK, resulting in superior performance for applications requiring low friction, high-speed rotation, quiet operation, or enhanced durability.

#### Materials

Superior Performance for Any Application



Materials research and development affects nearly every aspect of product performance. Through careful selection of material composition, heat treatment, and use of ceramic materials, NSK enables optimization of application performance. This may be through improvements in function, endurance, reliability, or even through improvements in cost effectiveness or production efficiency.

#### Numerical Simulation

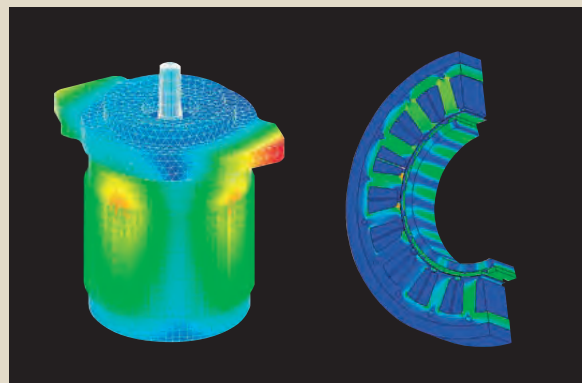
Turning Blind Risk into Trusted Reliability



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

#### Mechatronics

Technology Supporting People for a Safe and Comfortable Future



Mechatronics refers to the combination of mechanics and control technologies. NSK has cultivated knowledge of mechanics through years of product development and production. This knowledge is used in conjunction with motors, sensors, and circuits to develop mechatronic systems that add new functions, improve reliability, and increase performance in various industries while also improving convenience and safety in our daily lives.

## R&D Infrastructure

To increase its technical capabilities on a global level, NSK created the Technology Development Division Headquarters as an organization under the direct control of the president. It engages in tasks such as the planning and implementation of technology strategy, the control and management of technology-related risks, and human resources development. The Core Technology R&D Center and the New Field Products Development Center, which were set up under the Technology Development Division Headquarters, carry out R&D to meet society's needs and customer requests while collaborating with outside research institutions.

### ●Global Technology Development Structure

NSK operates technology centers in Japan, Europe, the Americas, and Asia to flexibly and swiftly respond to customers' wide-ranging needs in each region. At these technology centers, experts in various fields engage in the development of new technologies and next-generation products. Meanwhile, they also strive to enhance technical services while sharing information globally.

## Mid-Term Targets (FY2016 – FY2018)

To meet the needs of customers and society, the NSK Group will create new value by developing new fields and investing in new technology while assessing market trends, such as those in the evolution of automotive technology, IoT,\* social infrastructure, healthcare, and robotics. In terms of production, the Group is advancing the creation of smart factories, pursuing the practice of next-generation manufacturing.

\* IoT: Internet of Things. A paradigm for creating new value by gathering and analyzing data through the Internet from all kinds of things, including motor vehicles, home appliances, and industrial equipment.

## Main FY2015 Initiatives

In fiscal 2015, the final year of the Fourth Mid-Term Management Plan, the NSK Group worked at the development of new technology and new products for growth with a focus on profitability. The Group also focused on the development of a global technology system as a concrete means of strengthening its corporate fundamentals. NSK spent around 11.2 billion yen on R&D in fiscal 2015.

### ●Development and Deployment of a Global Bearing Design System

Customers' technological requirements, including products that are more sophisticated, lighter, and have lower friction, are becoming more and more exacting. Meanwhile, requests for product safety and reliability are also becoming more demanding.

NSK conducts its own customer satisfaction survey, in which "global technical support" and "shorter estimated delivery times" have surfaced as issues. To meet these requests and improve its customer service, NSK has developed a system that automates the checking of analysis and design value at the design phase and deployed it to its technology centers worldwide to serve as a single global bearing design system.

When product specifications requested by a customer are input based on design standards, this system automatically performs technical calculations and produces a 3D product model. Using this 3D model, the system automatically produces drawings after conducting strength verification and interference checking based on analysis using FEM.\* This enables the reliable prevention of human error in the design phase and enhancement of design quality. By deploying the system to its technology centers around the world, NSK has been able to standardize and streamline design, leading to drastic reductions in design lead times.

\* FEM: Finite element method. A method for analyzing factors such as the strength of a product based on approximate calculation.



A 3D model produced automatically by the bearing design system

### ●Innovation of Production Technology

The NSK Group's pursuit of technological innovation includes areas such as production facility design and product processing technology. The Group works hard to achieve maximum production with minimum labor and energy resources.

Development departments and production departments are cooperating in efforts to develop the most compact production equipment possible and to replace things like hydraulic machinery and motors used in existing equipment with the latest high-efficiency models.

## ●Development of Technical Human Resources

The NSK Group takes a global approach to technology dissemination and human resources development. NSK established the NSK Institute of Technology (NIT) in 2007 to develop its global technical human resources. At NIT, curricula and expected achievement levels are set separately for each faculty and academic year, and systematic education is provided using an exam-based credit system. (See p. 47 for details.)

## ●Collaboration with Outside Research Institutions

Apart from pursuing independent R&D, NSK also engages in joint projects with a variety of outside research institutions. By incorporating outside technology and perspectives into its own areas of expertise, the NSK Group aims to expand the scope and reach of its R&D.

One such example is NSK's participation in an R&D project aimed at increasing the commercial viability of wind power generation. NSK's partner is the New Energy and Industrial Technology Development Organization (NEDO), a national R&D organization in Japan. With renewable energy gathering more attention, NSK is conducting tests using wind turbines already in operation, studying ways to improve capacity utilization by making maintenance more efficient. Another goal of the project is to develop a monitoring system that can ascertain equipment problems and monitor life span of parts.

## NSK Products

### (1) Bearings for Railcars

In addition to delivering safety and reliability, railcars are also expected to get smaller and lighter in order to enable higher speeds and greater energy savings, while also ensuring ease of maintenance. NSK has contributed to the progress of railcars through the technical capabilities it has cultivated over its 100 years in business. NSK bearings are used in the cars of the Hokkaido Shinkansen line in Japan, which went into service in March 2016.

<http://www.jp.nsk.com/company/presslounge/news/2016/press0316a.html> (in Japanese only)



Axel bearings

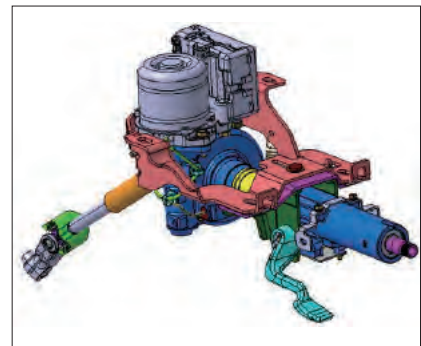


Bearings for gear boxes

### (2) Electric Power Steering

In the fight against climate change, there is strong demand for greater automotive fuel economy performance. Electric power steering (EPS) is said to improve fuel economy by 3% compared to hydraulic power steering. Additionally, electronic control-based drive assist helps improve the automotive environment, safety, and comfort. In January 2016, NSK developed an EPS system equipped with ACTIVE ON CENTERING™ control that changes the assisting force so that drivers can turn the steering wheel without feeling stress.

<http://www.nsk.com/company/presslounge/news/2016/press0203a.html>



### (3) Guidance Robot

Since 2004, NSK has been leveraging its mechatronics technology to pursue R&D into human-assisting guidance robots that help people in their day-to-day lives, seeking to help build a society where all people can live freely in safety and comfort. In fiscal 2016, it further refined the LIGHBOT™, a guidance robot for avoiding obstacles that is also equipped with a navigation function that helps people such as the elderly or those with visual challenges move around inside hospitals and other facilities. At the Special Zone for Robotics Industry, located in the Sagami area of Kanagawa Prefecture, NSK conducted tests with assistance from the prefectural government and in cooperation with hospitals, identifying issues and amassing knowledge for practical application.

<http://www.jp.nsk.com/company/presslounge/news/2016/press0223a.html> (in Japanese only)

<http://www.nsk.com/company/presslounge/news/2015/press1202d.html>

