Setting the Future in Motion with R&D

Balancing prosperity with reduced environmental impact is a challenge in establishing a sustainable society. For this reason, all kinds of things that support society, such as motor vehicles and home appliances, must be made more energy efficient, 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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Continuous Enhancement of R&D Activities

NSK’s Approach

At the NSK Group, product and technology development is driven by Four Core Technologies—tribology, materials, numerical simulation, and mechatronics—plus manufacturing engineering, collectively referred to as “Four Core Technologies +1.” R&D plays an essential role in realizing the NSK Corporate Philosophy, which clearly lays out the company’s responsibility to create a safer, smoother society and protect the global environment. R&D gives shape to our solutions, contributing to energy savings and reduced CO2 emissions. We also aim to speedily supply the market with sophisticated products, offering new features that accurately meet the needs of customers and society. Through R&D activities, we contribute to creating a brighter, more prosperous society for all.

Four Core Technologies + 1

**Tribology**
Studying, Clarifying and Controlling 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 mitigated 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.

**Numerical Simulation**
Simulated Recreation in Cyberspace to Predict Performance

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.

**Materials**
Unrelenting Pursuit of Performance Durability and Reliability

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

**Mechatronics**
Technology Supports People for a Convenient, Safe and Comfortable Future

Mechatronics integrates machine elements 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 applies new functions and performance to a range of industrial machinery, such as for automobiles and bio-medicine. It also contributes to greater reliability, as well as to convenience and safety in daily life.

**Manufacturing Engineering**
Giving Shape to Four Core Technologies

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 produce with high quality. NSK tackles these issues by applying AI 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 manpower requirements.
R&D Organizational Structures

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 & CEO. The organization oversees and executes tasks such as the planning and implementation of technology strategy, the control and management of technology-related risks, and human resource development. The Core Technology R&D Center, the New Field Products Development Center, and the CMS Development Center, which are under the umbrella of the Technology Development Division Headquarters, carry out R&D and product innovation to meet social needs and customer requests while collaborating with outside research institutions, universities, and venture firms.

Global Engagement in Technology Development

NSK operates technology centers at 16 sites in 10 countries and regions, including Japan, the Americas, Europe, China, South Korea, ASEAN, and India. This worldwide network aims to flexibly and swiftly respond to customers’ wide-ranging needs in each locale. At these technology centers, experts across a range of fields are developing new technologies and next-generation products to meet local needs in three categories: industrial machinery products, automotive products, and new field products. They are also working hard to enhance technical services and share information globally.

Fifth Mid-Term Management Plan Targets (FY2016 – 2018)

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, we are moving forward with the creation of smart factories and pursuing next-generation manufacturing practices.

* 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.

Initiatives in Fiscal 2018

NSK aims to build a more sustainable world. In fiscal 2018, we worked to develop products that contribute to improved efficiency in industrial machinery and equipment and enhanced fuel efficiency, compactness, and safety in automobiles. We are continuing our efforts to “expand into new growth fields” under our Fifth Mid-Term Management Plan, embracing this as a core challenge. NSK spent around 19.0 billion yen on R&D in fiscal 2018. Sales of new products* totaled 168.4 billion yen, or 18% of all sales.

*“New products” refers to products launched within the last five years.

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<tr>
<th>R&amp;D Expenses</th>
<th>Unit: Yen (billions)</th>
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<tbody>
<tr>
<td>FY2016</td>
<td>FY2017</td>
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<td>R&amp;D Expenses</td>
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<th>New Product Sales and Share of Sales</th>
<th>Unit: Yen (billions)</th>
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<tbody>
<tr>
<td>FY2016</td>
<td>FY2017</td>
</tr>
<tr>
<td>Sales of new products</td>
<td>214.7</td>
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<tr>
<td>New products’ share of total sales</td>
<td>23%</td>
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NSK Sustainability Report 2019

Continuous Enhancement of R&D Activities

Sixth Mid-Term Management Plan Targets (FY2019 – 2021)

To meet the needs of customers and society and to provide products that bring people joy, the NSK Group aims to delve even deeper into the Four Core Technologies +1 to make high-performance products—at an even higher level of quality—that can contribute to the world.

Specifically, we will increase productivity by strengthening our development capabilities through enhancement of assessment and simulation technology and the use of IoT. We will also actively utilize excellent expertise and technology from outside the Group.

Main Initiatives in Fiscal 2018

Development of Vibration Control Actuator for Train Cars

With the increasing speed of rail travel, an uncomfortable ride caused by train car shaking has become an important issue, necessitating technology to reduce passenger car vibration.

NSK developed a vibration control actuator—a motorized ball screw control device—to enhance the performance of control devices installed on train cars.

As a mechanism that converts a motor’s rotary motion into linear motion (the force that reduces car body vibration), the product uses a high-efficiency, low-inertia precision ball screw. It can actively control lateral swaying and shaking from outside the car body, reducing vibrations with good responsiveness.

The product has already been installed in rail cars and demonstrated that it can improve ride comfort by substantially reducing vehicle shaking. In this way NSK is enabling more comfortable rail travel at higher speeds.

This product won the 2018 “CHO” MONODZUKURI Innovative Parts and Components Award (Japan Brand Award) sponsored by MONODZUKURI Nippon Conference and The Daily Industrial News (The Nikkan Kogyo Shimbun).

Innovation in Production Technology

The NSK Group’s pursuit of technological innovation includes production facility design and product processing technology. We work hard to achieve maximum productivity without wasting labor or energy. Our development and production divisions are working together to develop the most compact production equipment possible and to replace existing hydraulic machinery and motors with high-efficiency models. We are also working to create smart factories that adopt the latest production systems using robots.

Development of Engineering and Technical Human Resources

R&D in the NSK Group is driven by engineers with world-class talent. Developing and raising the skills of engineers is essential to meeting market needs accurately and creating new value. This is why we take a global approach to technology sharing and human resource development, dispatching technical experts from Japan to educate global staff and bringing overseas staff in for training at technology centers and plants in Japan. In fiscal 2007, we established the NSK Institute of Technology (NIT) to nurture global engineers. Each year over 400 students strive to learn specialized technical knowledge and skills. (See pp. 62-63 for details.) We understand that interaction among people from diverse industries and lines of work can lead to innovative ideas, so we actively send staff to lectures, training sessions, and seminars outside the Company.
Expanding Engagement in Open Innovation

Enhancing the progress of innovation is key to creating the “super-smart society” (Society 5.0) advocated by the Japanese government. Open innovation combines original technologies and ideas from different industries and fields, including those created by universities, local governments, and venture companies in and outside Japan. We leverage open innovation to search for new business seeds, building on the original technologies and products we have developed as a bearing manufacturer.

Through open innovation, we support the creation and development of new markets and also invigorate our own organization.

Examples of Open Innovation

• Joint development related to dynamic wireless charging through participation in the second phase of the Cross-ministerial Strategic Innovation Promotion Program (SIP) led by Japan’s Cabinet Office
• Signed a sponsorship agreement with CARTIVATOR Resource Management, an incorporated association aiming to make flying cars a reality
• Capital tie-up with WHILL, Inc. in the field of next-generation personal mobility
• Investment in SoftWheel Ltd., a manufacturer of wheels for personal mobility, such as wheelchairs and bicycles
NSK’s Approach

The NSK Group sees intellectual property as essential for ensuring revenues and developing its business. The NSK Code of Conduct Concerning Compliance clearly states that personnel must strive to create, protect, and utilize intellectual property; must handle intellectual property rights with great care; and must not infringe on the intellectual property rights of others.

Intellectual Property Management Structure

NSK has established an Intellectual Property Department under the Technology Development Division Headquarters. In cooperation with division headquarters and technical departments in each region, the Intellectual Property Department formulates and implements an intellectual property strategy for the entire NSK Group and implements intellectual property efforts in step with global expansion of the business.

We have always been aware of the importance of Group-wide intellectual property initiatives. NSK is one of Japan’s leading filers of patent applications in the field of mechanical parts, as many of our main products belong to this sector. We also aim to acquire stronger patent rights that can contribute to future business. The technology and intellectual property divisions study patentability within each development topic. These efforts have accumulated the NSK Group a large number of patents: 4,425 in Japan and 3,074 outside Japan as of March 31, 2019. We make effective use of this intellectual property as a management resource in global business development.

We also actively pursue trademark rights in an effort to maintain and develop confidence in the NSK brand. In January 2018, the registered trademark “NSK” acquired protection in China as a “well-known brand.” This is the result of our corporate track record in China and extensive efforts to protect the NSK brand.