

## Research and Development

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Minebea manufactures and sells a wide range of products around the world. These include ball bearings, precision machinery components that incorporate ball bearings, aircraft components such as rod-end bearings and high-end fasteners, as well as electronic components used in state-of-the-art electronics equipment. Minebea and Minebea Group companies work closely together on R&D in each of these areas.

The Minebea Group is also dedicated to the development of hybrid component products that integrate the basic technologies that go into making its machined components, rotary components, electronic devices, and other components.

Minebea has development bases in Japan (Karuzawa Plant and Hamamatsu Plant), Thailand, China, the United States, and Europe. These bases leverage their individual expertise and supplement each other to speed up the development of new products in new business opportunities. Our facilities in Karuzawa, Thailand and China have all been ISO17025 certified and are moving the entire Minebea Group forward in analyzing and reducing emissions of hazardous substances targeted by environmental regulations, including those banned by the European Union's Restriction of Hazardous Substances (RoHS) directive.

The total amount of R&D expenses in the Group were ¥7,490 million. Among them, ¥1,527 million was for basic research at material science laboratories in Thailand and China, such as basic materials analysis, and other research that cannot be allocated to individual segments.

R&D activities for each segment in the current fiscal year include:

#### Machined Components

R&D in this segment remained geared toward our mainstay bearing products (i.e. ball and rod-end bearings) with a focus on developing basic tribological technologies for materials and lubricants, etc., as well as on oil fill, electrochemical machining (ECM), diamond-like carbon (DLC) and other processes. We are working with a keen eye to responding to the needs of manufacturers in emerging areas of the IT, home electrical appliances, automobiles and aerospace industries. Reliability engineering aimed at minimizing particle generation, extending product life, enhancing/reducing electro conductivity, etc. as well as applied engineering are at the heart of our work in this area.

In the miniature ball bearing that is the essence of precision processing technology, we have made efforts to produce smaller products. Pivot assembly that is one of the applications of miniature ball bearings has contributed to the magnificent expansion of HDD recording capacity.

Recent progress in the area of aerospace industry bearings includes the development and approval of tie-rod mechanical assemblies, trunnion bearings for main landing gear and a wide range of bearings that will go into flight control systems for new models released by U.S. and European aircraft manufacturers. These R&D successes are built on the same technology used in our rod-end bearings.

R&D expenses in this segment totaled ¥1,061 million.

#### Rotary Components

Our mainstay motor products in this segment include information motors (fan motors, stepping motors, brushless DC motors, vibration motors, and brush DC motors) and HDD spindle motors. We are working to enhance our various core analysis technologies, control technologies and materials technologies. Our aim is to be the first to launch a range of state-of-the-art products that respond to growing customer requirements for compact, highly efficient (low energy consumption), quiet, and reliable components designed for various types of motors and applications.

R&D work on magnetic application products harnesses our expertise in materials technology, core technologies and product-related technologies. Ongoing work in this area continues to yield such outstanding products as rare earth bond magnets and heat-resistant magnets for use in high-performance motors. As a countermeasure against the rising price of rare earth, we have developed magnet that can remarkably reduce the use of the expensive rare earth.

The majority of HDDs now use perpendicular magnetic recording to achieve higher recording densities, and thus ensuring the cleanliness of components has become a crucial consideration. That's why we have put so much effort into developing clean manufacturing technologies that ensure a high level of cleanliness in our mainstay HDD-related products, including our bearing units, spindle motors and base plates.

R&D expenses in this segment totaled ¥3,427 million.

#### Electronic Devices and Components

Progress in the area of display-related products includes the development of a new high-brightness, high-efficiency LED (light emitting diode) backlight for LCDs targeting the cellular phone, smart phone, tablet PC, handheld game console, and digital camera markets.

After developing a plastic molding technology capable of accommodating larger, thinner optical devices and increasingly fine optical patterns we have one more development to add to our list of outstanding technological achievements that includes ultra precision machining, mold production and molding technologies.

This development gives us the technological foundation needed to expand into the area of LED backlights for notebook and desktop PC monitors, for which LCDs have become the preferred type of display, and we are now proposing high-brightness, high-efficiency, and thin products. We also developed a thin lenses for LED lights using our optical technology fostered in the development of backlight products. The thin lens has larger transparency compared with the existing products and can save more energy.

Advances in electronics-related products includes state-of-the-art LED backlight driver circuits for large-sized LCD TVs and driver circuits for LED lighting applications.

Our shift from analog to digital control circuits will significantly reduce the number of parts used as well as improve control precision, enabling us to reduce engineering lead time.

R&D expenses in this segment totaled ¥906 million.

#### Other

The main products in the other segment are PC keyboards, speakers and special devices.

R&D expenses in this segment totaled ¥569 million.