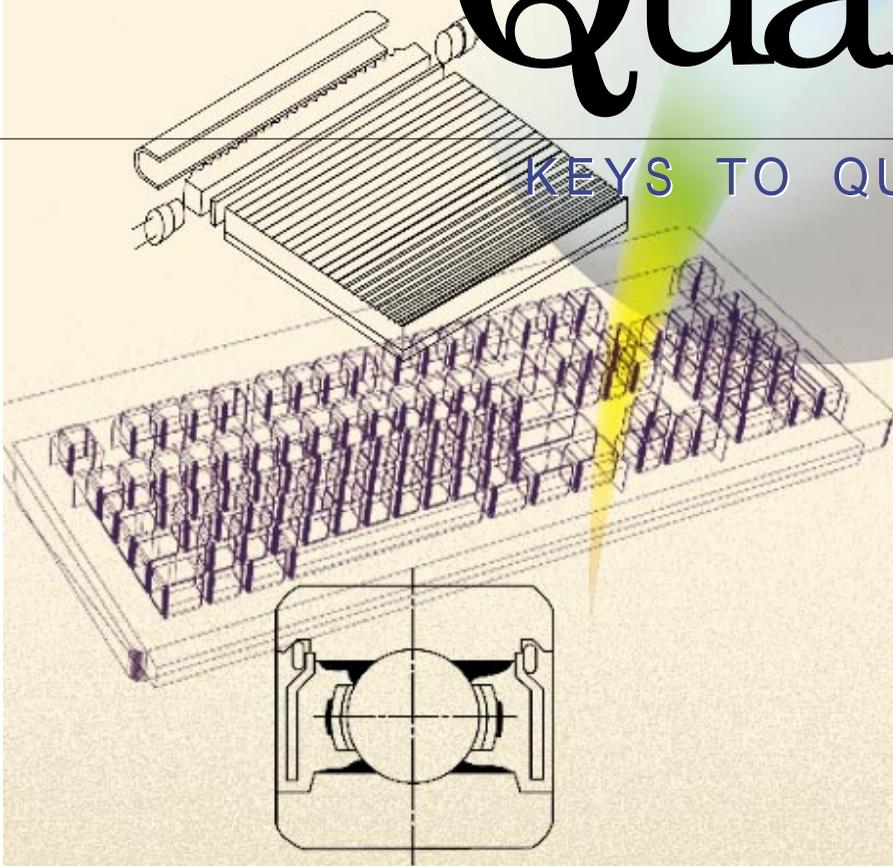




Quality

KEYS TO QUALITY



Developing Unparalleled Precision Machining Technologies



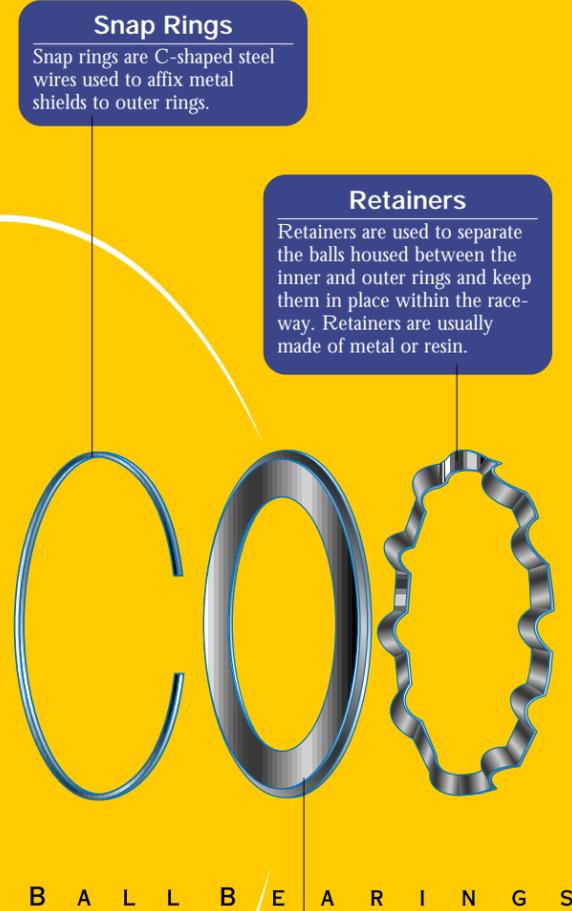
BALL BEARINGS

Tomihiro Maruta, Managing Director, General Manager of Bearing Manufacturing Division, and in charge of the Rod-end Manufacturing Division, Karuizawa Manufacturing Unit; General Manager, Fujisawa Manufacturing Unit

Often called the primary element of industry, ball bearings are found in innumerable products in contemporary society. The precision of the ball bearings used in these products plays a crucial role in determining their performance.

Miniature and small-sized ball bearings, particularly those up to 22 millimeters in external diameter, are the most prevalent classes and are used extensively in information and telecommunications equipment, as well as household electrical appliances. Minebea is the world's leading manufacturer of these ball bearings, with a 65% global market share.

Growing technological sophistication in key customer industries continues to spur demand for higher levels of ball bearing precision. In particular, the growing technological sophistication of HDDs is increasing demand on bearing manufacturers to achieve constantly higher levels of quality. Moreover, such industries demand this improved quality at greater-than-ever levels of production. Minebea's unmatched competitiveness in this market and reputation for product reliability are due to its unique vertically integrated manufacturing system, which facilitates internal sourcing of all parts used in its ball bearings.



TOPIC

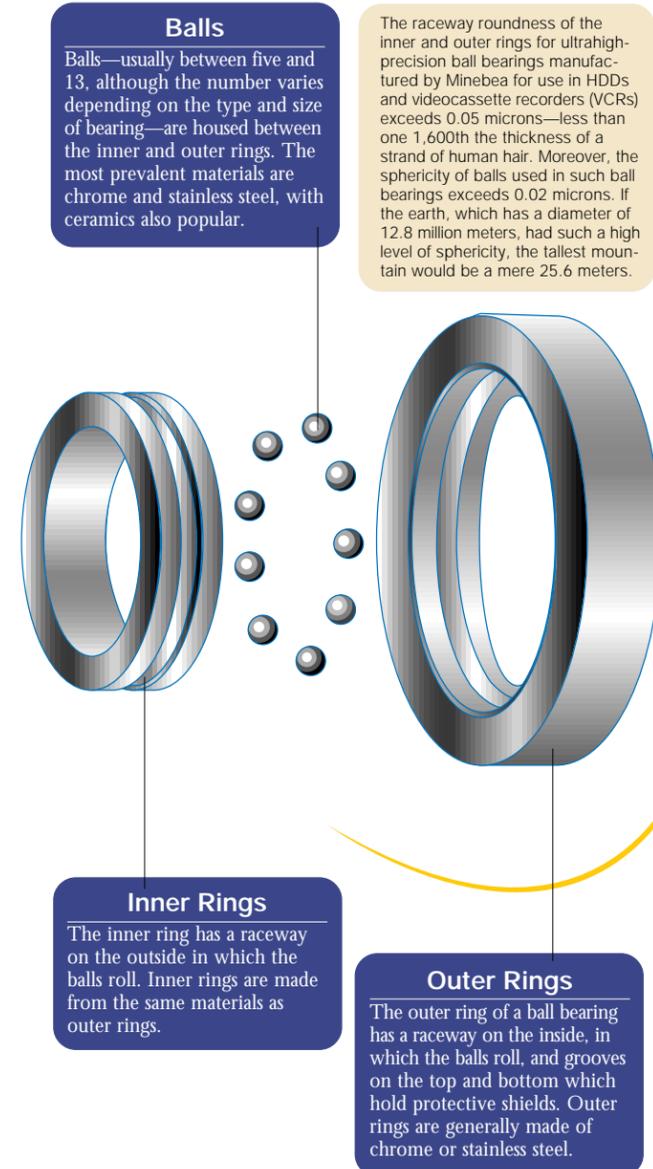
Raceway Roundness and Ball Sphericity

Improving the raceway roundness of a ball bearing's inner and outer rings and the sphericity of the balls greatly enhances the bearing's rotating speed, non-repeatable run-out (NRRO), sound level and life span. This, in turn, strengthens the quality of the motors or other components in which the bearing is used. Minebea develops and builds all jigs and tools used in the production of ball bearing parts in-house, enabling it to ensure consistently high levels of raceway roundness and ball sphericity for ball bearings manufactured at its 10 mass-production facilities worldwide.

Minebea produces approximately 8,500 different varieties with outer-ring external diameters between three millimeters and 28 millimeters, with monthly output worldwide totaling approximately 120 million pieces.

● Bearings

External diameter (mm) 3 5 7 9 11 13 14 16 20 22 28

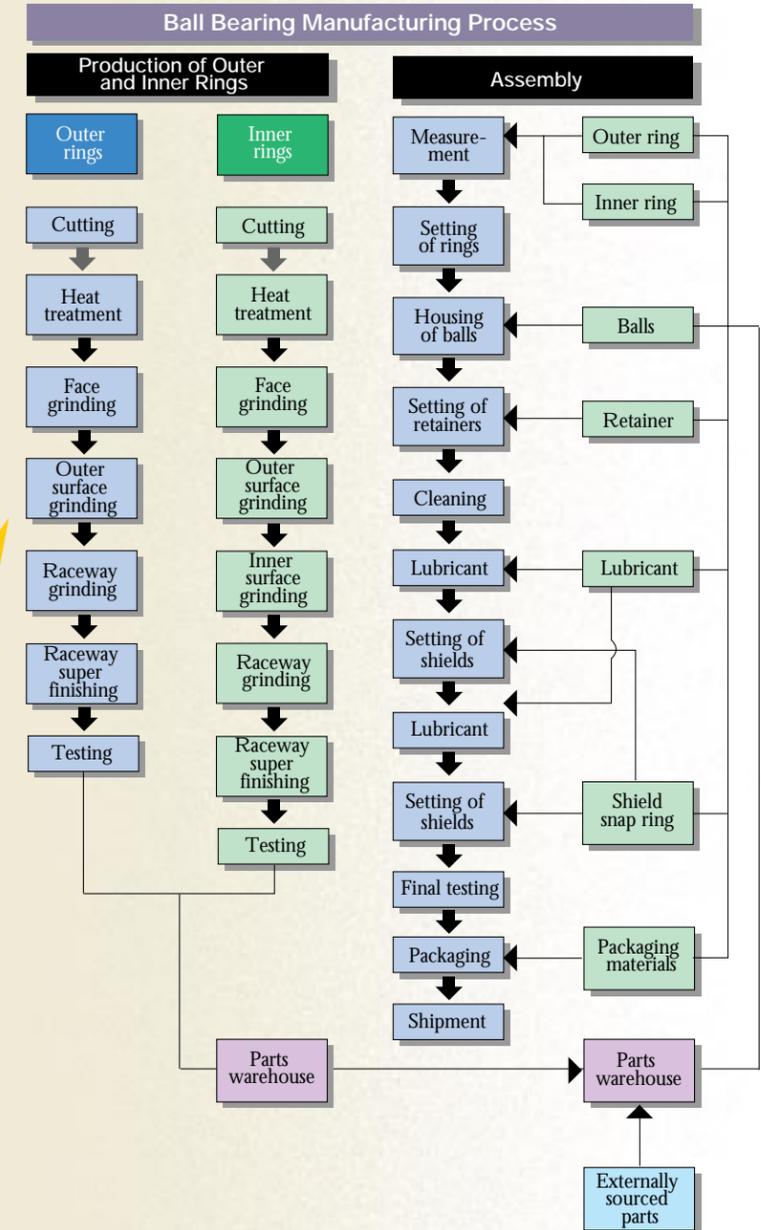


Internal Sourcing of All Parts

The typical ball bearing comprises an outer ring, inner ring, between five and 13 balls, two retainers, two shields and two snap rings. Enhancing the precision of each of these parts is essential to raising the quality of the finished ball bearing. Minebea manufactures all parts used in its ball bearings in-house, giving it complete control over part precision and enabling it to mass-produce ball bearings of unsurpassed quality.

Minebea's Vertically Integrated Manufacturing System

The level of precision in each ball bearing production process is another essential factor in determining the quality of finished products. Minebea conducts all processes in-house, as well as manufactures most production and assembly equipment used therein, thus ensuring complete control over the precision of each process and facilitating mass-produced superior-quality ball bearings.



Applying Fundamental Technologies to the Manufacture of High-Precision Components



Components for HDDs

Rikuro Obara, Senior Managing Director, General Manager of 1st Manufacturing Headquarters and Karuizawa Manufacturing Unit

The growing presence of PCs in both the home and office and rapid technological advances are stimulating demand for HDDs with increased capacity and higher reading and writing speeds.

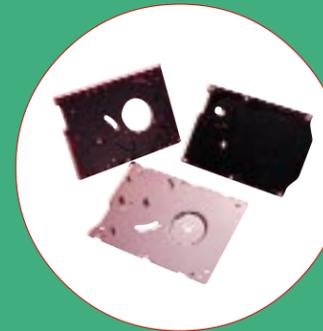
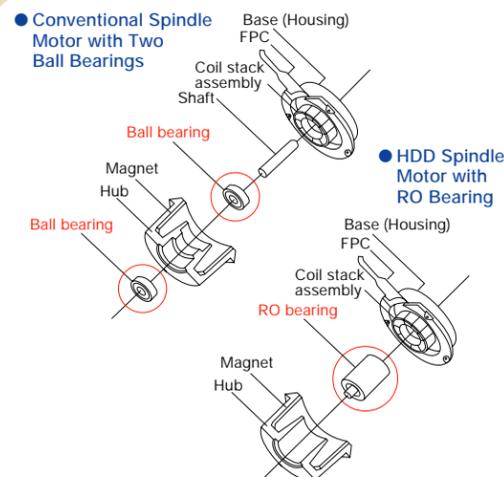
Spindle motors, of which Minebea is a world-leading manufacturer, are crucial components in HDD mechanisms. Improving the rotating speed, NRRO, sound and life span of an HDD spindle motor is thus an effective way to enhance the performance of an HDD. These factors are determined by the quality of the ball bearings used. Minebea's spindle motors contain the Company's own high-precision ball bearings, as well as other internally sourced parts, ensuring outstanding reliability. Superior accuracy is also demanded of pivot assemblies for positioning HDD magnetic heads. Here, too, Minebea has applied its high-precision bearing technologies, earning the Company a commanding 75% share of the global pivot-assembly market.

TOPIC

RO Bearings



RO bearings—named for their inventor, senior managing director Rikuro Obara—are unique, high-precision ball bearings developed by Minebea for use in HDD spindle motors. Conventional HDD spindle motors contain two standard ball bearings. The groundbreaking RO bearing, however, features two raceways on the inside of the outer ring and one each on the shaft and the inner ring fitted on the shaft, essentially combining the functions of two ball bearings in one while improving the degree of parallelism of the raceway, minimizing rotational error and facilitating more compact designs. RO bearings are also used in pivot assemblies.



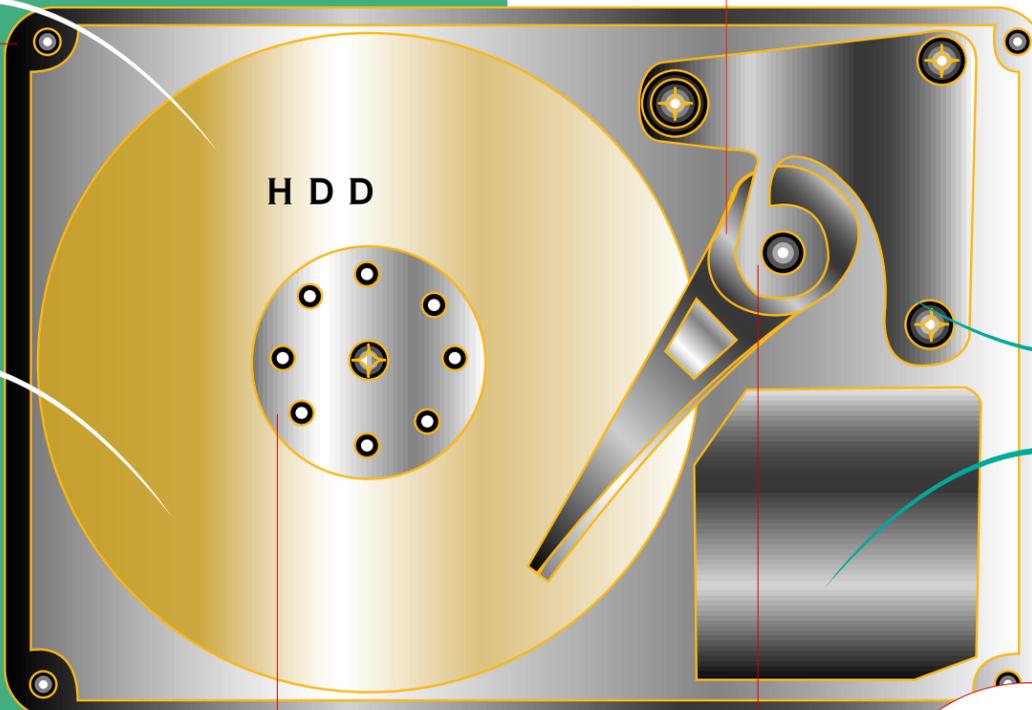
Die-cast Parts

Minebea produces die-cast bases for HDDs in-house. We also sell motors for HDDs comprising a base and a spindle motor.



Die-cast Parts

Minebea manufactures the die-cast swing arm, upon which the HDD's magnetic head is mounted. We also sell integrated units comprising a swing arm and a pivot assembly.



Spindle Motors

With the exception of winding wires and leads, Minebea produces all parts for HDD spindle motors—from high-precision machined parts, such as ball bearings, shafts, housings and bases, to magnets—in-house.



Pivot Assemblies

Minebea produces all parts for its HDD pivot assemblies, which are mounted on die-cast swing arms.

A Leading Share of the Global Market for Ball Bearings

Minebea uses its own high-precision ball bearings in its small-sized motors and pivot assemblies, which has earned these components an outstanding reputation for reliability. With the increasing technological sophistication and rapid diffusion of PCs, office automation (OA) equipment and household electrical appliances, demand for Minebea products is growing, as is the Company's share of key global markets for electronic devices and components.



Spindle motors for HDDs



Stepping motors



Pivot assemblies

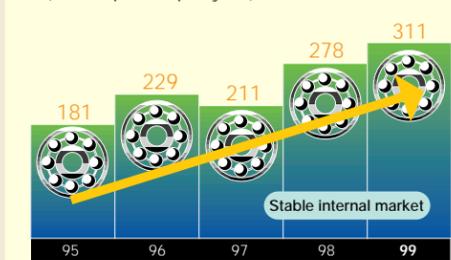


Fan motors

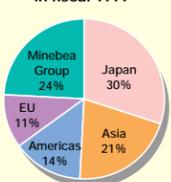
A Highly Stable Internal Market

Internal sourcing also generates powerful synergies. By using its own ball bearings, Minebea ensures the outstanding quality of its various small motors, pivot assemblies and other components. Outstanding quality attracts increased orders which, in turn, stimulates orders for ball bearings. Minebea has thus created its very own massive and highly stable ball bearing market.

Production Volume of Ball Bearings for Internal Use (Million pieces per year)



Breakdown of ball bearing sales in fiscal 1999



Striving Constantly for Higher Levels of Precision through Extensive R&D



PROCESS-RELATED R&D

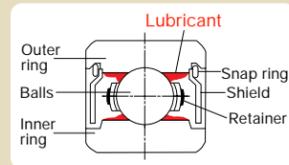
Takayuki Yamagishi, Senior Managing Director, General Manager of 2nd Manufacturing Headquarters and Hamamatsu Manufacturing Unit

Minebea's unmatched machining technologies have made it the most competitive manufacturer of ball bearings and precision components in the world. The Company thus places a high priority on R&D aimed at enhancing these technologies.

Minebea manufactures the bulk of its miniature and small-sized ball bearings and small motors and other components at its mass-production facilities in Southeast and East Asia under its unique vertically integrated manufacturing system. This system also allows the Company to apply the results of R&D carried out at parent plants in Japan swiftly and effectively to production elsewhere in Asia. Minebea thereby ensures the same level of product quality at all plants.

T O P I C

In-House Development of Lubricants



Lubricating greases and oils are used to prevent metal friction between the inner and outer rings and the balls in a ball bearing, thus ensuring smooth rolling and long bearing life. By capitalizing on its know-how and experience as a leading manufacturer of miniature and small-sized ball bearings, Minebea has begun developing its own high-quality lubricants at the Thai R&D Center. The Company is confident that these efforts will contribute to significant improvements in the quality of its ball bearings.

R&D Center, Thailand

Minebea's Thai R&D Center is located within the Bang Pa-in site, one of four manufacturing sites in Thailand that together account for approximately 60% of the Company's total production volume worldwide. Equipped with state-of-the-art analytical instruments, the center aims to resolve problems that affect precision and develop solutions that can be applied promptly and effectively on the production floor. The Thai R&D Center's activities focus on contamination control and material science, and are aimed at ensuring the reliability of finished products.

Materials Analysis Using X-Ray Photoelectron Spectrometer



X-ray photoelectron spectrometers are used to investigate the surface chemistry and interactions of solid surfaces of metal and organic materials. The Thai R&D Center's X-ray photoelectron spectrometer enables researchers to determine, for example, whether metal discoloration is the result of oxidation or corrosion caused by chlorine, sulfur or other substances.

Outgas Analysis Using Gas Chromatograph-Mass Spectrometer (GC-MS)



GC-MS is widely used to determine the chemical properties of substances. At the Thai R&D Center, researchers use the GC-MS to analyze gases released by the adhesives used in spindle motors, enabling them to identify gases that could potentially lead to functional problems for HDDs in field use.

R&D at Parent Plants

Manufacturing system at mass-production facilities

Enhancement of product quality and productivity

Development of dies, jigs and tools

Improvement

Development of maintenance technologies

Improvement

Development of manufacturing technologies

Improvement

Development of mass-production technologies

Improvement

Introduction of these technologies at mass-production facilities

Improvement

Introduction of mass-production technologies at mass-production facilities

Improvement

Product development

Improvement

Small-lot production

Improvement

Development of mass-production technologies

Improvement

Materials development

Improvement

Introduction of mass-production technologies at mass-production facilities

Improvement

Mass production



Minebea's Global R&D Network

Minebea has established a global network of facilities to conduct R&D and testing in key product segments, thus facilitating swift and accurate responses to customer needs.



- **Karuizawa Manufacturing Unit (Japan)**
 - Product development (bearings, small motors and other products)
 - Technological development (manufacturing and mass-production technologies)
 - Product analysis and evaluation
 - Support for overseas R&D activities



- **Hamamatsu Manufacturing Unit (Japan)**
 - Materials R&D
 - Product development (electronic devices and components)
 - Technological development (manufacturing and mass-production technologies)
 - Support for overseas R&D activities



- **Thai R&D Center (Thailand)**
- **Singapore R&D Center (Singapore)**
 - Chemical analysis, cleanliness evaluation and acoustic testing of HDD components and other products



- **Minebea Electronics (UK) Ltd. (United Kingdom)**
- **Power Systems, Inc. (United States)**
 - Design and development of switching power supplies



- **Precision-Motors-Deutsche-Minebea-GmbH (Germany)**
 - Design and development of various precision small motors, notably spindle motors for HDDs



- **NMB (U.K.) Ltd., Airmover Division (United Kingdom)**
 - Design and development of fan motors



- **New Hampshire Ball Bearings, Inc. (United States)**
- **Rose Bearings Ltd. (United Kingdom)**
 - Design, development and production of aircraft bearings for customers in the United States and Europe—the world's two largest aerospace markets



- **NMB Technical Center (United States)**
 - Evaluation and testing of ball bearings for various customers, notably the Big Three U.S. automakers



- **Fujisawa Factory (Japan)**
- **NMB Technologies, Inc. (United States)**
 - Design and development of PC keyboards

Maximizing Basic Technologies to Cultivate New Markets



VERTICALLY INTEGRATED MANUFACTURING SYSTEM

Yoshihisa Kainuma, Senior Managing Director, General Manager of U.S./European Region Sales Headquarters and Operation Headquarters

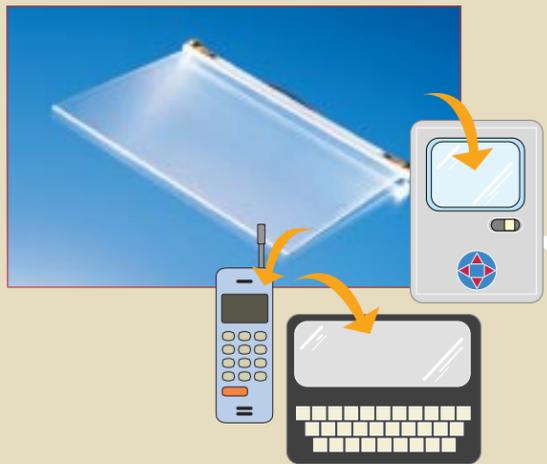
To enhance the quality of mass-produced ball bearings, small motors and other mainstay products, Minebea strives constantly to improve the precision of the parts it uses and its ability to supply these parts to its production facilities worldwide. The success of the Company's efforts reflects its vertically integrated manufacturing system. This system encompasses all processes, from production and maintenance of dies and molds, to production of pressed, injection-molded and die-cast parts, machined parts such as shafts and gears, and magnets, final assembly and testing. Each process is monitored by a specialist based at either the Karuizawa or Hamamatsu manufacturing unit.



TOPIC

Reflective Color LCD Front Light Unit

One of Minebea's new products is an exclusive front light unit for reflective color liquid crystal displays (LCDs). Developed in-house using the Company's exclusive design and simulation software and advanced injection-molding technologies, this new front light unit comprises a light-conducting, transparent polymethyl methacrylate (PMMA) panel made from a number of fine prisms and white light-emitting diode (LED) chips. When attached on a reflective color LCD, the front light unit significantly improves the brightness and readability of the display in dark environments. This product consumes less power, has a lower-profile structure, is lighter in weight and more compact than conventional LCD front lights, making it particularly suitable for mobile applications. As a consequence, Minebea anticipates rapid growth in demand.



Expanding Markets for Minebea's Products

This synergistic combination of precision machining technologies—which facilitate internal sourcing of most of the parts used in its finished products—mass-production technologies and advanced R&D allows Minebea to keep abreast of the growing popularity and sophistication of information and telecommunication equipment and household electric appliances by supplying a wide range of advanced components.

With technological progress, notably digitization and the increasingly information-oriented nature of household electrical appliances, the rapid growth of mobile telephones and personal digital assistants (PDAs) and the improved performance of electronic products for automobiles, demand for superior-quality components is rising. Accordingly, Minebea expects to see its share of these and other key new markets expand.

Key Uses for Minebea's Bearings and Components

Desktop PCs	Notebook PCs	Facsimile machines	Laser printers
Copy machines	Electronic music and game devices	Air conditioners	Audio components
Televisions	VCRs	Interphones	Portable cassette players
Video cameras	Telephones	Sliding bookshelves	Microwave ovens
Sewing machines	Micro-computerized wash/dry toilets	Oil fan heaters	Window shutters
Dehumidifiers	Rice cookers	Blenders	Vacuum cleaners
Air sanitizers	Refrigerators	In-line roller skates	Low tables with built-in heaters
Weight scales	Alarm clocks	Oil and gas water heaters	Fishing reels
Remote-control devices	Electric power tools	Ball bearings	Keyboards
		Fan motors	Speakers
		Hybrid-type stepping motors	Transformers
		PM-type stepping motors	FDD subassemblies
		Spindle motors for HDDs	Head carriage assemblies
		Spindle motors for FDDs	Magnetic heads
		Induction motors	Switching power supplies
			Inductors
			Investors for backlighting units
			Strain gauges
			Load cells
			Pivot assemblies
			Tape guides

