



# Contributing to Society with Energy-efficient Motors

## Engineers with a Passion for Manufacturing

*The Minebea Group offers a wide range of products. Behind those products are the developers striving on a daily basis. Here, we focus on development of energy-efficient motors that was promoted on a unified basis by industry, academia and government.*

### Becoming champions in the energy-efficient motor field

As global environmental and energy problems intensify, energy conservation has become an urgent challenge for society as a whole. In what would become the company's first NEDO-designated project (see column), Minebea began developing magnets for small, energy-efficient motors in May 2009.

Motors of all types and sizes are used in a wide range of everyday

equipment, including automobiles and electrical appliances for the home. Today, over nine billion motors are in annual use around the world in many different locations and applications, and approximately 57% of the electric power consumed in Japan is used to power motors. If the efficiency of domestically powered motors could be increased by 1%, the energy efficiency impact would equal that of a reactor in a nuclear power plant, and this field is attracting attention as having great importance in solving the problems of global warming and energy. The

component that determines the motor's efficiency—the magnet—is the key. Increasing the magnetic force is directly related to boosting the efficiency of the motor.

The originator of the project, Fumitoshi Yamashita, explains the motive behind the project: "Motors utilizing magnets have been in use since around the 1960s, but while the prevailing demand at that time was for horsepower, recent years have seen an increasing need for products that are small and efficient, and have long operating lives and low environmental impact.

## Column

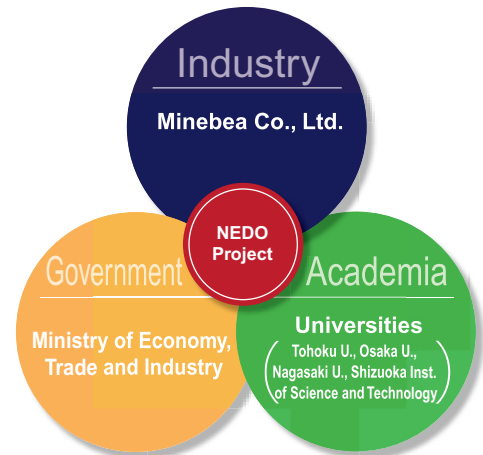
**What is NEDO?**

New Energy and Industrial Technology  
Development Organization

NEDO's mission as an incorporated administrative agency under the control of the Ministry of Economy, Trade and Industry is "addressing energy and global environmental problems" and "enhancement of Japan's industrial competitiveness."

The core of its activities consists of coordination between industry, government and academia to promote research relating to the development and dissemination of new energy sources and energy-efficient technologies. NEDO delegates research and development administration to public research institutes, and provides funding and other support for research and development projects selected through publically invited applications.

In advanced technology development fields that are risky and difficult for private-sector enterprises to enter on their own, NEDO project designation makes possible funding support and more efficient research and development through collaboration with universities. The goal is rapid practical implementation and dissemination of innovative technologies through this sort of collaboration between industry, government, and academia.



trol stood as a major obstacle to the practical implementation of energy-efficient motors.

According to Yamashita, "Regardless of how high the efficiency is, if the motor is extremely noisy, one cannot say it is an excellent product. Those of us in corporate research and development must grasp the needs of customers who will ultimately use the product. However, that is why our company has an advantage in this area: we are not a specialized magnet manufacturer, but rather are engaged in magnet development based on a comprehensive understanding of motors. We are confident that we have, without a doubt, the industry's number one technical strength in this field, and we were convinced we could do it."

This is how the magnet development project started. For three years after originating it, Yamashita alone was responsible for all aspects of the project and furthering the research. In January 2009, when it finally appeared that the probability of success had risen to approximately 50%, Yamashita applied for NEDO designation as a Subsidized Innovation Implementation Project. Competition for such designation is keen, and above all, it was Minebea's first application.

"NEDO designation would mean funding, and assistance from universities, which would allow us



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to enhance our development effectiveness. We were convinced that this research was necessary for future society, and early release of a product to the market was important commercially as well as for contributing to society. Our intention was to become a champion in this area," says Yamashita.

In March 2009, NEDO recognized the research for its originality and significance, and announced its decision to designate the research as a NEDO project. It was the instant when Yamashita's idea as a researcher had created a huge opportunity.

Amid this trend, when we considered what it was that we in our position could and must do, the resulting idea was the development of magnets for small, energy-efficient motors. Since we must work in any case, we wanted to do something that would benefit the world."

Of course, simply increasing the magnetic force of the magnet does not make for an energy-efficient motor. This is because the stronger the magnet used, the more difficult it becomes to use the motor. When the magnetic force of a more powerful magnet is transmitted as torque (the power to rotate the shaft), the additional force manifests as vibration that can cause excessive noise, and on the contrary makes for a motor with poor energy efficiency. To efficiently transmit powerful magnetic force to the shaft as torque, the magnetic flux from the magnet's surface (the flow of magnetism from the magnet) must be regulated and its power controlled in complex ways. Magnetic flux con-



Nishimura recalls:  
"We ran into obstacles constantly."

**The team's strength and each member's trial and error opened the path to success**

Four new members were assigned to the development team to further the now NEDO-designated project. One of them, Shinsaku Nishimura, recalls that "It felt extremely fulfilling to be involved with the development of such advanced technology."

Meetings involving the entire team were held approximately once a week. The rest of each member's time was spent in single-minded, repeated experimentation related to the research problem for which he or she was responsible, and day after day, research results accumulated. "To control the magnetic flux, we had to repeatedly experiment

with variations in the shape and angle of the magnet, as well as minute variations in the location of the N- and S-poles and the angle of the magnetic flux. But since the magnetic flux we are controlling is invisible, it was very difficult to achieve the results we anticipated. We also ran into obstacles constantly," says Nishimura.

Furthermore, as a NEDO-designated project, the deadline and goals were clearly defined in advance. In addition to the heavy burden of responsibility involved in using taxpayer money, there was also the possibility that support could be terminated before the deadline if the development progress or prospects were poor. Unlike in conventional development projects, the pressure of time and responsibility weighed heavily on the shoulders of each member.

The team members' abundant creativity overcame these challenging circumstances and pushed the project forward. "Even at night when I was at home in bed, when some sort of idea occurred to me, I wanted to go to work and test it. I couldn't wait till morning," says Yamashita with a laugh. Every member was constantly looking for new ideas and turning them into action. Recalls Yamashita, "If we tried something and it didn't work, we came up with the next idea. If that didn't work, then the next. The important thing was to come up with second and third approaches and keep up the fight."

Osamu Kobayashi, a member who handled overall administration

for the group, adds that "even with one goal, there may be an unlimited number of ways to reach it. Yamashita has always been a tremendous idea man, and the other members, with much more limited career experience, had a strong determination to reach the goal, and they joined with Yamashita in coming up with ideas."

Moreover, researchers in the collaborating academic institutions—Tohoku, Osaka, and Nagasaki Universities and the Shizuoka Institute of Science and Technology—acted as strong partners in supporting the team's efforts. Prior to NEDO designation, at a stage before the project's direction was finalized, the academic researchers participated in meetings and had numerous discussions with the research team members. After the project was under way, they



The advanced bond magnets developed by the team (foreground) and motors planned for future development (rear).



handled basic technological verification and development tasks, including verification of the mechanism of magnetic force reduction and characterization of physical properties of raw magnetic powder, and provided valuable information.

"Sometimes when our opinions differed, they came and stayed overnight in our research lab so we could discuss. At any rate, we worked hard to absorb all of their knowledge, and the two sides greatly stimulated each other. I think we built a relationship where we can work together to promote research and development whenever needed, not just on this project," notes Yamashita.

### Contributing to society through technology

The period of support as a NEDO-designated project ended on schedule in March 2011. The team succeeded in reaching the original goals of the project by creating a smoothly rotating small motor that consumes 30% less resources and 5% less energy. Yamashita laughs, "I'm confident that we created something we can be proud of to the world. Frankly, we were working under a lot of pressure, so it feels like a weight has fallen from our shoulders."

Nishimura adds with a serious look, "Of course, we were able to achieve a certain degree of results, but we haven't reached the stage where we can celebrate the 'completion' of something. We developed the magnet, but commercialization of a motor using it lies in the future. The happiest thing for us engineers is when technology we developed makes its appearance as a product and reaches the customer. Only when commercialization takes place can we claim success. As of today, we've only taken a single step forward."

Numerous hurdles still lie in wait on the road to commercialization. Joint research with automotive manufacturers and other enterprises must be promoted to create a product that not only has advanced functioning, but embodies attributes needed for it to sell well. Nishimura and his team will keep working to achieve that goal.

Nevertheless, this project is exerting a significant influence on the company as a whole, points out Kobayashi. "Minebea has always had a strong 'manufacturing company' orientation. One can't say that it was highly aggressive with respect to technological development, but I feel that through this project, the opportunity is starting to arise to develop technology that no other company has. In addition, we learned through this NEDO project that research carried out in collaboration with universities is extremely meaningful. I feel that going forward, we definitely must increase the amount of development where enterprises and universities can demonstrate synergy by pooling their strengths."

This project also had great significance in terms of the cultivation of young engineers, with team members from different generations cooperating to promote development. "Young engineers have a tremendous shortage of experience when it comes to seeing something they have developed go out into the world to contribute to society. In that aspect as well, this project became an extremely good opportunity. I wanted to make this experience an opportunity for the young team members themselves to enhance their skills as engineers, and I believe the result was to motivate the young members."

Reducing the size of the motor and raising its efficiency through



"We definitely must increase development where enterprises and universities can demonstrate synergy." (Kobayashi)

magnet development will not only reduce the impact on the environment, as in this case, but should be an important technology for applications in a wide range of fields, including medicine and social welfare. The possibilities for Minebea to contribute to society through technology are likely to grow more and more. Yamashita is spurring his younger-generation staff to "aim to become world-class specialists," and for his part, Nishimura is keen for them to become "engineers who can introduce the new technology first to the world." The seeds planted through this project are slowly but surely starting to send forth shoots for the future.



The development team (from right):

Osamu Kobayashi (Manager, Motor Core Technologies Department, Engineering Development Division, Rotary Component Business HQ)  
 Dr. Fumitoshi Yamashita (Chief Engineer, Motor Core Technologies Department, Engineering Development Division, Rotary Component Business HQ)  
 Osamu Yamada (Senior Engineer, Motor Core Technologies Department, Engineering Development Division, Rotary Component Business HQ)  
 Shiho Ohya (Motor Core Technologies Department, Engineering Development Division, Rotary Component Business HQ)  
 Shinsaku Nishimura (Assistant Manager, Motor Core Technologies Department, Engineering Development Division, Rotary Component Business HQ)