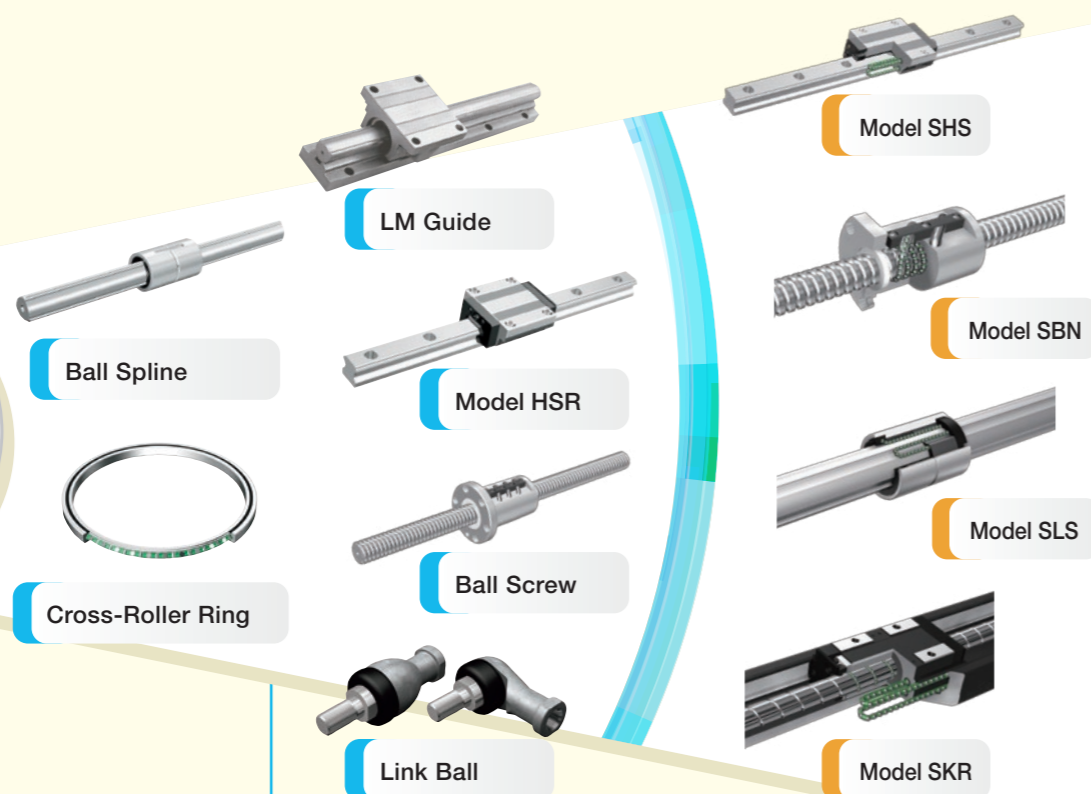


THK's Expertise and Core Technology Combine to Create

While the world faces various challenges, from global warming-induced climate change to major earthquakes that could strike at any moment, the shift toward automation has accelerated in response to the labor shortage brought about by an aging population and declining birth rate. Out of our desire for our products and technology to contribute to the advancement of society, we have used the expertise we have accumulated since our founding to create a variety of products.

Toughness
High Quality
Know-how



Products for Existing Technology

Using rotary motion to achieve linear motion was said to be impossible, but we focused our efforts on that challenge and developed the **ball spline**, which uses load-bearing balls that roll along a raceway. We then introduced the **LM Guide**, which featured a ball spline combined with a mounting fixture. This product can bear heavy loads, and it has helped machines become faster and more compact and precise. The **Model HSR**, which can bear significant loads from four directions equally, became the world standard for LM Guides. We developed one new product after another: standard products that can be shipped quickly, a **ball screw** that can use a single nut instead of two to reduce backlash, and a rotary **cross-roller ring**, which is a single bearing that can handle a load from any direction.

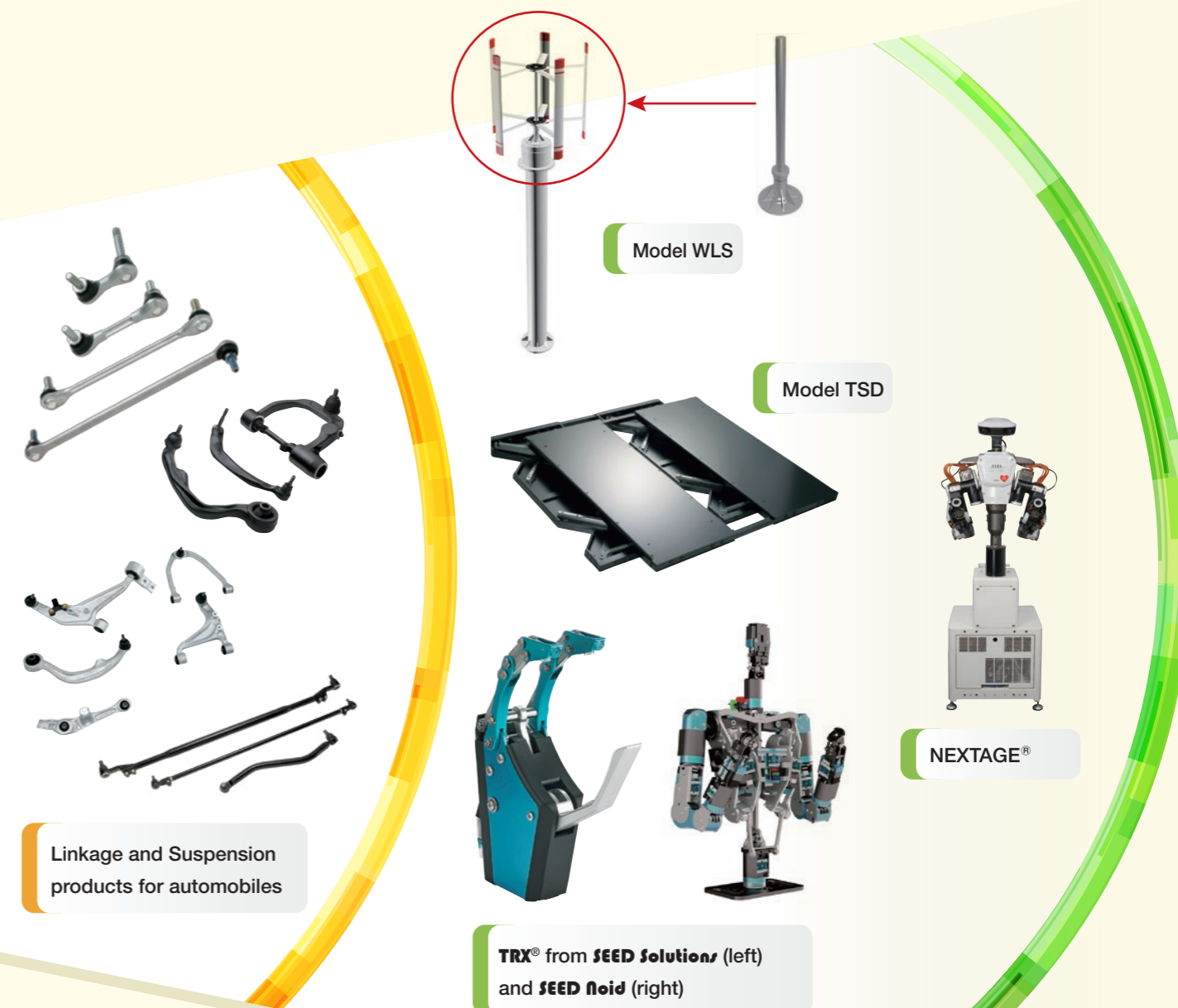
Link balls are products made by die casting metal around a high-precision, spherical metal bearing, and then by using a special kind of welding process to attach a shank. Through this original manufacturing method, the shape of the spherical bearing's surface is transferred to the casting's surface, enabling the bearing to move smoothly and with a minimal amount of clearance. Because of its compact design, these products have been used in various automotive applications, including transmission control units and gear sticks.

New Products Derived from THK's Core Technology

The Caged Ball LM Guide **Model SHS**, High-Speed Ball Screw with Caged Ball **Model SBN**, Caged Ball Spline **Model SLS**, and Caged Ball LM Guide Actuator **Model SKR**—a product that combines an LM Guide and ball screw—feature ball cages (retainers) that were developed to prevent contact between balls. These products generate little noise and boast a long period of maintenance-free operation. Their applications are expanding to welfare and other fields close to the general population, including platform edge doors that protect train and subway passengers and medical equipment that is required to move easily and bear heavy loads, such as devices used for CT scans and MRIs. The Special Features section of this report discusses how **TOSHO Inc.** is using

our LM Guides. Conventional steel stabilizer links have been widely used to connect stabilizers and suspension systems to improve automotive stability while driving, but we used our original die casting methods and welding technology to create and introduce aluminum stabilizer links that are cast out of recyclable aluminum. These stabilizer links are 30% to 40% lighter than conventional steel products, which improves fuel efficiency. Similarly, we previously supplied cold-forged steel tie rods, which transmit steering wheel input to the tires, but we then developed a new method of forging aluminum and began selling aluminum tie rods. These products are also 30% to 40% lighter and help improve fuel efficiency.

Products with Many Applications



Products for the Next Generation

Global Warming

In the field of renewable energy expected to reduce greenhouse gases, starting with our trials of vertical-axis and horizontal-axis wind turbines at our Sendai plant, we have introduced the Low-Torque Shaft Unit **Model WLS**, which meets the requirements for IEC 61400. The Special Features section of this report discusses how the **Yamaguchi Prefectural Industrial Technology Institute**, a local incorporated administrative agency, is using the low-torque shaft unit as a way to revitalize local industry.

Earthquakes

Over the last decade in earthquake-prone Japan, there have been several earthquakes registering at a seismic intensity of 6 or higher, such as the Great East Japan Earthquake and Kumamoto Earthquakes. Amid concerns of an earthquake occurring directly beneath Tokyo, in the Tokai region, or in the Nankai Trough, there is demand

for ways to minimize damage, protect corporate assets and information, and quickly respond and resume normal operations. Our solution to those concerns is our **Model TSD** seismic isolation system. The Special Features section of this report discusses how **JyouSenji**, a Honmon Butsuryu Shu temple, and **Akita University Hospital** use our seismic isolation systems.

Coexisting with Robots

We have developed **SEED Solutions** components for service robots that will closely benefit people ranging from children to the elderly, all of whom can experience an increased desire to learn by operating the robot or enjoy walking and talking with the robot. We introduced the **SEED fluid**, which provides customers with components and software that can be tailored to their specifications, and the **TRX**, the product JAXA utilized on the International Space Station that revolutionized

robotic hands used in space with its ability to pinch, grip, and hold with a single unit. The Special Features section of this report discusses how **NS Solutions Corporation** is using THK products to conduct trials aimed at implementing 5G in 2020.

Aging Population and Declining Birthrate

With the population growing older and birth rates declining, problems related to the decrease in the working age population are expected to arise. To maintain production capability and improve productivity, we introduced the **NEXTAGE** humanoid robot, which has cameras installed in its head and no need for a fence around it. It performs simple and repetitive or dangerous tasks, freeing people to perform work with high added value. The Special Features section of this report discusses how **SECOM INDUSTRIES CO., LTD.**, is using NEXTAGE to work alongside humans.

TOSHO Inc.

Ohta, Tokyo, Japan

TOSHO
Your best pharmacy solution

THK's LM Guide Improves the Repeat Accuracy and Speed of Dispensing Medicine



General Manager, Technology Planning Department
Junichi Umeda

Did you know?

On average, people in inpatient care receive three injections (including IVs) per day. Furthermore, each injection administered is compounded, containing three types of medication. Therefore, if there were 1,000 patients, that would mean roughly 10,000 doses of medicine would be administered per day (approximately 3 types of medicine x 3 injections x 1,000 people). Naturally, each individual patient uses different medications, which means that an extraordinary amount of work goes into providing injections at hospitals every day.

In the past, pharmacists or nurses would go through the process of gathering and compounding (adjusting) medications. However, this was an onerous task in extremely busy clinical settings, and it would lead to medical errors. While it takes time for oral medicine to be absorbed and take effect after use, a higher percentage of injections are fast-acting, so there is the risk that a mistake in compounding could be irreversible and directly impact the life of the patient.

When visiting a pharmacy, you have probably had the experience of receiving your medications inside individual bags. In fact, some of our company's main products are machines that dispense powder medicines and tablets into bags. Utilizing the experience we have gained since our founding, we have created a fully automatic injectable medicine dispensing machine to eradicate compounding errors and to reduce the workload of pharmacists and nurses.



UNIPUL 5000, the latest fully automatic injectable medicine dispensing machine

The roles of fully automatic injectable medicine dispensing machines and THK's products

Our previous models would dispense one day's worth of injectable medicine for patients, but our latest model, UNIPUL 5000, is able to dispense one injection's worth—the smallest dose. That means that nurses simply need to mix the medicines that are dispensed and then inject them. This machine also checks the dosage and combination of drugs on the doctor's prescription, enhancing its ability to eradicate medical errors.

The UNIPUL contains ampoules for approximately 200 types of medicine, and it can reliably dispense injectable medicines into ampoules, vials, or other containers based on the practitioner's electronic medical records. What allowed us to achieve what other company's products could not were the THK LM Guides used in our new UNIPUL 5000. With previous models, the difference in how the assembler tightened each bolt affected the dispensing accuracy. In our attempt to eradicate medical errors, the accuracy of each component has been crucial in eliminating elements of uncertainty. By utilizing THK's LM Guides for the internal components that move vertically and horizontally, we were able to improve the repeat accuracy and accelerate the process of dispensing medicine. Using special seals on the LM Guides also made our products maintenance-free. No problems have occurred with any of the delivered products.

The customers who have installed our product have praised it highly. When one was reassigned to a different facility in Japan's national hospital system as part of a routine transfer and encountered problems with a similar, non-TOSHO product, they remarked, "This wouldn't happen with a UNIPUL."

At TOSHO, we work day and night to find ways of automating the process of handling medicine in the pharmaceutical field. To prevent the accidental loss of precious human life through medical errors and automate manual daily tasks, we will continue proposing equipment that will allow health care providers to focus solely on practicing medicine.

Yamaguchi Prefectural Industrial Technology Institute

山口県産業技術センター
YAMAGUCHI PREFECTURAL INDUSTRIAL TECHNOLOGY INSTITUTE

Ube, Yamaguchi Prefecture

THK's Technology Aids Local Manufacturing Growth



Yamaguchi Prefectural Industrial Technology Institute
Seiji Yamada, D.Eng.

The "Made in Yamaguchi" small wind turbine

The Yamaguchi Prefectural Industrial Technology Institute is a core technology support center for companies in our prefecture, providing engineering support and conducting R&D. In our longstanding efforts to promote the use of renewable energy, we focused on creating a vertical-axis wind turbine with a comparatively simple blade shape and whose orientation does not need to change with the direction of the wind. We selected the optimal blade by installing various types of blades and conducting wind-tunnel tests, and we developed a controller that enables peak operation from the wind turbine. In order to develop a "Made in Yamaguchi" small wind turbine by utilizing our research and the manufacturing capabilities of companies in Yamaguchi, we moved forward with a working group of five local companies that had the expertise required to develop a wind turbine. After attending a presentation on special bearings for wind turbines held at a wind power symposium, we exchanged information with THK, which has a plant in Yamaguchi, on several occasions. We asked THK to participate in the working group, and they graciously agreed.

For this project, THK proposed using a vertically split bearing shaft that would eliminate the center shaft to

improve air flow around the center of the vertical-axis wind turbine. Once we began actual tests of our completed wind turbine, we encountered several issues, such as the blade's arms lacking sufficient strength and the controller malfunctioning. We continued to make improvements and try again. Among the malfunctions, there was an issue where the lack of a center shaft caused the blades to deform from the centrifugal force as they rotated, and the upper bearing was damaged because the arms were repeatedly moving up and down. When we explained the situation to THK, they immediately rushed over to the turbine's location and proposed several alternative solutions in no time. To prevent the arms from moving up and down, which was our biggest problem, we ultimately decided to go with the proposal that involved using a slender shaft at the center, and THK remade the Model WLS Low-Torque Shaft Unit for us.

Working toward commercialization

At present, we are working on solving the issue with the controller. Once that is resolved, it will mark the completion of this original, locally created wind turbine. The rated output of our current prototype is 1 kW, but we want to use the data we have collected to develop and commercialize a wind turbine capable of 5 to 10 kW. From providing engineering guidance to coming on-site the moment there was an issue, THK has been actively involved and generously cooperated with our efforts to enhance the technological capabilities of local companies, and we are sincerely grateful. Furthermore, as a wind turbine developer, it is greatly encouraging to see a company actively working to use their technology in turbines. With THK's development of a brand-new low-torque shaft unit designed for vertical wind-axis turbines, as well as their other efforts, I believe THK will have an important role to play in the renewable energy field, which must continue progressing to prevent global warming.



Improved small wind turbine on the institute's grounds

JyouSenji, Honmon Butsuryu Shu Temple

Shibuya, Tokyo, Japan



THK's Seismic Isolation System Protects the Statue of Honmon Butsuryu Shu's Founder Enshrined at JyouSenji



Administrator
Senshin Okamoto

The statue in which the founder's spirit dwells

The core practice of Honmon Butsuryu Shu Buddhism is devotedly chanting the mantra *Nam-myoho-renge-kyo*, which is based on the teachings of Nichiren. The Lotus Sutra is at the foundation of our belief. This sutra contains 28 chapters, with the first half (chapters 1 through 14) being the Shakumon (reflection), and the second half (chapters 15 through 28) being the Honmon (true form). Our sect is called Honmon Butsuryu Shu (true teachings of the Buddha from the Honmon) because Nichiren identified eight chapters (chapters 15 through 22) of the Honmon as the primordial sutra that contains the mantra that will save those living in the Latter Day of the Law.

It is believed that our core practice of repeatedly chanting *Nam-myoho-renge-kyo* allows us to commune with spirits of heavenly beings and brings about blessings in a form we can see. It is a practice that anyone can do regardless of age or gender, and it does not require you to visit the shrines or temples located in each region. We presently have around 300 temples in Japan in addition to locations in the United States, Brazil, Australia, South Korea, and Taiwan, spreading our work and praying for happiness for all of human society.

Honmon Butsuryu Shu's main temple is Yuseiji in Kyoto, where a statue of Nichiren is enshrined. This statue is a symbol of Honmon Butsuryu Shu's teachings and an object of worship for many believers, and great care is taken in its preservation. Replicas of this statue are kept in temples all around Japan, including JyouSenji.



Statue enshrined at the center of the altar with a seismic isolation system installed

THK's seismic isolation system protects our statue from earthquakes

After the Great Hanshin-Awaji Earthquake and the Great East Japan Earthquake, many temples near the epicenters reported that their statues had moved or fallen over. Nichiren's spirit dwells in these statues, so they must be protected at all times, in every situation. Some temples reinforced and earthquake-proofed their buildings as a precaution against earthquakes, but at JyouSenji we decided to install a seismic isolation system when renovating our main temple (which houses the statue) and placed our order with a store that sells Buddhist articles. Fortunately, that store had already considered the idea of using a seismic isolation system, so the conversation went smoothly.

When selecting a company, we arrived at the decision to install THK's seismic isolation system based on an introduction from the construction company that performed the renovations, and also by hearing word from members of our faith who said that THK was a bearing manufacturer we could trust.

We originally wanted to install a seismic isolation system for the entire altar, but the salesperson we worked with provided us with a lot of advice, informing us that they could provide a compact product sized for the statue's pedestal and suggesting that we add a steel plate because the wooden statue weighed very little. We decided to go with their suggestions.

We have a lot of believers who come to worship and many monks who work at our temple. I feel very reassured knowing that our statue is being protected by THK's seismic isolation system. Several other temples are already planning on installing seismic isolation systems for their statues. In the future, I hope that the use of seismic isolation systems will spread to the statues enshrined in temples in every country around the world.

Akita University Hospital

Akita, Akita Prefecture



Safeguarding Medical Information During Disasters



Deputy Director, Division of Medical Informatics
Atsushi Ohsaga, M.D., Ph.D.

The role of the Division of Medical Informatics

Akita University Hospital, which sees approximately 1,800 patients a day, is designated as an advanced treatment hospital—a medical institution that performs highly specialized and advanced medicine. We have striven to maximize our use of medical information in order to create a system that eliminates wait time as much as possible so we can provide examinations that reduce the burden placed on patients. The medical information recorded in the system includes the patient's personal information and results from blood tests, CT scans, MRIs, chest x-rays, EKGs, and more. This data is then shared with doctors, nurses, or others involved in clinical practice. Our role as the Division of Medical Informatics is to enhance patient convenience and create an environment that will allow our hospital's information system and network infrastructure to function stably even during a disaster.

Medical information backup system

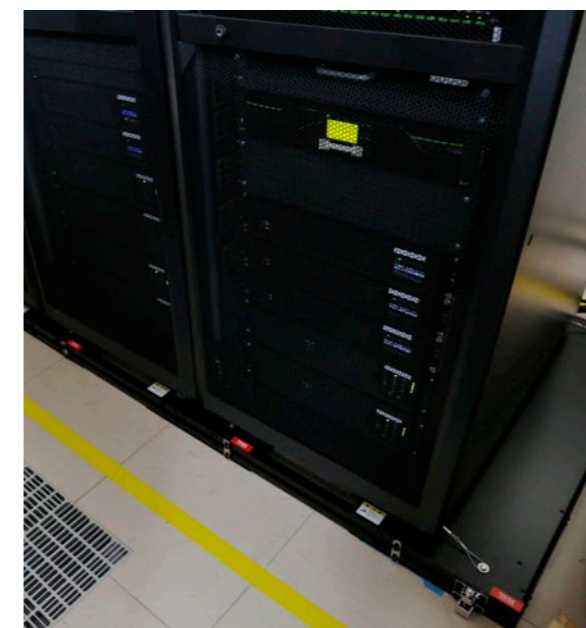
We upgrade the servers and client computers that manage medical information at our hospital to a new system every five to six years to ensure durability. The server racks must be relocated or removed with every upgrade, so we cannot

secure them to the floor. To protect the servers from earthquakes, we used to employ a method that would connect the racks and keep them upright. With that system, however, we had to deal with the nuisance of reconnecting the racks every time we upgraded.

The reason we made the leap and installed a seismic isolation system when upgrading to our current, eighth-generation system was to prevent the server racks from falling over. Our building suffered no significant damage during the Great East Japan Earthquake, and our information systems did not suffer physical damage, either. While Akita Prefecture is known for having few earthquakes, I was not able to dispel the concern of the server racks falling with the earthquake-proofing method we were using.

I am not an expert on earthquakes, but THK's miniature seismic isolation system allowed me to become familiar with the product's internal mechanisms. With the seismic isolation simulation vehicle, I was also able to experience how effective this technology is against tremors equivalent to those felt during the Great East Japan Earthquake. I decided to install seismic isolation systems made from Linear Motion (LM) Guides because I was confident they would be able to protect our equipment from vertical and horizontal ground motion during an earthquake, and because they can be installed easily, without needing to be secured to the floor.

We successfully installed the seismic isolation systems under our server racks in November 2017 without needing to shut down our equipment. Finally, we installed a total of 17 systems. Considering the trends of AI use in the medical field, the digitization of medical information will likely continue to accelerate. In order to provide patients with prompt service by safeguarding their important information and quickly making it available to the hospital, we intend to continue promoting the seismic isolation of our servers as necessary to protect them from earthquakes.



Seismic isolation systems used to prevent the server racks from falling over during an earthquake

NS Solutions Corporation

Chuo, Tokyo, Japan



The **SEEDroid** Makes High-Speed 5G Robots a Reality



Telecom Solutions Division
Tetsuo Ogawa

Changing the future with next-generation 5G mobile communication

Since the invention of mobile phones, we have seen the creation of new data transmission functions, first enabling us to use e-mail and the internet, and now making it commonplace to watch videos on your phone (see below). About once every 10 years, a new generation of technology replaces the old one. We currently use 4G technology, and a number of experiments are being conducted with the aim of

Year	Type	Description	Characteristics
1979	1G	Analog	Car phones, but only in urban areas
1993	2G	Digital	E-mail, pagers, and mobile phones
2001	3G	Approx. 14 Mbps* speed	Internet access on mobile phones
2012	3.9G	Ultra-high speeds up to 100 Mbps	High-quality image viewing on smartphones
2017	4G	100 Mbps or more	0.1 s delay, suitable for video conferences and online gaming
2020 (estimated)	5G	10 Gbps	0.001 s delay, compatible with autonomous and remote operation technology

*Mbps: Unit for data transmitted per second. The higher the number, the higher the speed.



Robot writing in sync with the dancer's movements

putting 5G into practical use in 2020.

Entering the 5G Idea Contest held by NTT Docomo was our initial push to become involved with 5G. I used to work at a steel plant under our parent company, where employees wore fire-resistant clothing as they worked in the production floor's harsh environment. The idea of having robot doubles take over this work prompted our decision to develop a remote humanoid robot system.

Finding out about THK products solved our problems

We are currently on our third generation of robots. Our second-generation robots were unable to grasp objects via remote operation, causing us considerable trouble. Another company introduced us to THK, and when we saw their products, we observed 1) a wide operating range comparable to that of a human, 2) any added accessories can work simultaneously with existing mechanisms to make products, and 3) THK products are small, lightweight, and compact, which is exactly what we were looking for. In August 2017, we developed a robot that integrated THK's **SEEDroid**. It only took three months to complete. THK possesses stability and technical expertise you cannot find at any other component manufacturer. I can say that developing this robot would not have been possible without THK technology.

Despite being remotely controlled, the robot mirrors the operator's movements with almost perfect precision thanks to the communication delay of only 0.001 seconds. A head-mounted display allows the operator to see what the robot is seeing, and through VR (virtual reality), the operator can feel the sensation of grasping whatever the robot arm has grasped. This robot presents an array of possibilities for applications, from the difficult work environment described above, to operating a stethoscope at a clinic on a remote island, to acting as a first responder by putting out fires with a fire extinguisher. In February 2018, we presented this technology at the Mobile World Congress in Barcelona, Spain, where it was used for a demonstration of the art of Asian calligraphy.

SECOM INDUSTRIES CO., LTD.



Shiroishi, Miyagi Prefecture

Overall Productivity Quintupled with the Installation of **NEXTAGE®**



Chief Product Developer
Isao Onoda

Product Developer
Ryota Baba

President
Toshiya Miura

Improving production efficiency and increasing quality in anticipation of a smaller working population

As a Group company under SECOM CO., LTD. (Japan's first security assurance company and industry leader), we design and manufacture security equipment. The SECOM Group has created a system that takes responsibility for everything from research and development to the design, manufacture, installation, and maintenance of security equipment to achieve an even higher quality of service for our customers. As a part of this effort, the entire SECOM Group works together under the concept of "ALL SECOM," aiming to create a "pleasant and convenient society, where anyone can live without worry."

In recent years, greater focus on crime prevention has led to an increase in demand for security equipment. In anticipation of a smaller working population and efficiency improvements in manufacturing, we installed a robot in our work-intensive inspection process. In this process, every product is placed in a specialized fixture and must undergo a number of checks, which include different types of electrical signal measurements, displays, and operations. Because of this, the employee must maintain a high level of concentration. In an effort to lighten the burden on employees, we decided to install a robot with the dual aim of improving the working environment and improving quality by preventing mistakes.



NEXTAGE® performing the complex inspection process in place of people

Benefits of installing NEXTAGE®

Our conditions for selecting a robot were as follows:

1. Dual-armed for better operation efficiency
2. Able to perform many intricate operations accurately
3. Able to fit in a single person's work area
4. Programming that we can edit for adjusting fine movements and image recognition

Our inspection process is very difficult, and we did not receive any encouraging responses from the system integrators we spoke with. We did, however, get a single optimistic reply from THK INTECHS: "Let's give it a shot!" As it turned out, NEXTAGE® met all of our conditions, and it can accurately manipulate switches on the scale of just a few millimeters while correcting positions, a task that is difficult even for people. Furthermore, the cameras in its head check the process instructions step-by-step on the monitor while performing each operation, so it never skips a check.

We purchased one NEXTAGE® robot in August 2016, and with assistance from THK INTECHS as necessary, we programmed it to work with our inspectors. In February 2017, we began making full use of automation in the inspection process. For a while after installation, we only had it operating alongside other employees during the day. Since September of that year, however, we began having the NEXTAGE® run at night—when no one else is around—and inspect the products made throughout the day to increase production output.

By thinking about the productivity of the overall process, we can now perform the inspection process both day and night with NEXTAGE®, so we have gone from being able to make 1.1 products per person each hour to 5.9, a five-fold increase in labor productivity. So that manpower will not affect our ability to consistently supply products, in the future we plan to automate our product transport and assembly processes, while at the same time installing more NEXTAGE® robots and dedicating them to the inspection process.