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Special Feature

"iArmS"

The surgical support robot developed in Japan based on a totally new concept

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The Japanese government has designated the medical, nursing care, and healthcare-related industries as focus field in its New Growth Strategy. Accordingly, the government is encouraging the informatization and internationalization of medical services and the development of innovative medical equipment and life-support robots. Against this backdrop, Shinshu University, Tokyo Women's Medical University, and DENSO Corporation have launched a joint project, and created a surgical support robot, "iArmS," by orchestrating medical, engineering, and industrial technologies.

Aiming to Improve the Quality of Surgical Operations and Reduce the Burden on Surgeons

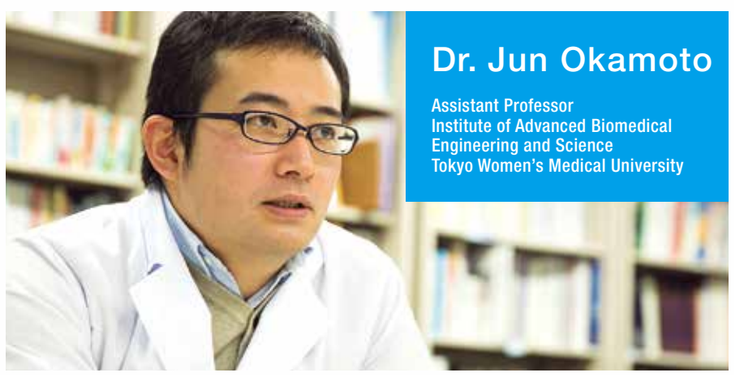
iArmS was developed as an "intelligent arm" support robot to aid neurosurgeons. In a neurosurgical operation that demands precise execution of highly detailed procedures, the surgeon usually uses a microscope to enlarge the operating area. The delicate procedures required to connect blood vessels of 1 mm or less in diameter in the brain with a suture with a thickness of 0.02 mm take more than 12 hours in some cases. To keep the hands steady, surgeons hold their arms tightly against the body, positions the little fingers on the patient's skull, and takes other necessary measures. However, there are limited places that surgeons can use to stabilize their hands, and the affected area can be accessed only from a certain direction. Since even a slight error in hand movement could directly lead to a serious problem, the surgeon is under immense mental and physical strain.

iArmS was developed to solve this problem. It supports the surgeon's arm from the elbow to the wrist during the operation. The robot arm smoothly follows the movement of the surgeon's arm, and during surgical procedures, it holds the surgeon's arm in place to abate the natural shaking of the hand and reduce fatigue.

iArmS is very easy to use. The surgeon does not even have to be aware of its operation. iArmS's intuitive operation system moves the robot arm exactly as intended by the surgeon. Surgeons simply place their arm on the robot arm. Then, iArmS's built-in sensors accurately sense the delicate movements of the surgeon's arm. When the surgeon moves the arm, the robot arm follows the movement accurately. When the surgeon stops moving the arm, the robot arm locks in position. When the surgeon wants to free the arm from the robot arm, it is necessary only to apply a slight pressure on the robot arm. The robot then sets itself on standby.

Assistant Professor Jun Okamoto in the Institute of Advanced Biomedical Engineering and Science at Tokyo Women's Medical University participated in the development of iArmS as an engineering researcher. He describes the aim of development.

"The purpose of the robot is to reduce strain on surgeons during surgical operations. No matter how advanced the robot function is, if it is difficult to use, the robot cannot serve its intended purpose. So, we aimed to achieve easy operation from the very start of the development."



Dr. Jun Okamoto
Assistant Professor
Institute of Advanced Biomedical Engineering and Science
Tokyo Women's Medical University

Maintaining High Levels of Safety and Reliability Without the Use of an Electric Motor

A non-clinical research report verified that iArmS is capable of curtailing the hand tremors of surgeons by about 70 %. Many people outside the neurosurgical field also evaluated iArmS highly. For example, otolaryngological surgeons can use iArmS in an operation for chronic sinusitis. In this type of surgery, an endoscopic camera is generally used. Since the surgeon performs the operation while holding the camera in one hand, there is great strain on the surgeon. By using iArmS to support the arm holding the endoscope, the surgeon can concentrate on the surgical operation.

In a neurosurgical operation, the surgeon performs surgical procedures with one or both arms held steady by iArmS, while looking through a microscope.

The term "surgical support robot" may give the impression to some people that the robot performs surgical operations on behalf of the surgeon. Research on the development of robots to perform surgical procedures has a long history, but iArmS was developed on a unique idea conceived through a completely different approach: taking maximum advantage of surgical procedures by human beings.

The development concept was proposed in 2006 by Dr. Tetsuya Goto, a neurosurgeon at Shinshu University Hospital who had conducted research on medical robots, and the basic design was worked out by the development team headed by Dr. Okamoto. In 2012, Shinshu University, Tokyo Women's Medical University, and major automotive parts manufacturer DENSO Corporation initiated a joint project to work on the robot design for commercialization.

After about three years, the development team completed "EXPERT," the predecessor of iArmS. The main feature of EXPERT was that it did not use an electric motor to power its movement, in order to eliminate the risk of operation stoppage in the event of a power failure or erratic operation caused by malfunction. This makes one wonder what kind of mechanism is used for the robot operation.

" iArmS utilizes gravitational balance and the doctor's arm movement for its operation. The robot arm is structured much like a balancing toy. The weight of the surgeon's arm on the robot arm causes the weight hanging on the opposite side of the robot arm to move to adjust to gravitational force, thus maintaining balance. The joint section of the robot arm also contains a weight. All the parts are linked ingeniously to achieve smooth movement of the robot arm to follow the surgeon's arm movement. To support surgical operations, the robot has to be safe and reliable, feature simple design and appropriate size to reduce burden on the user, and allow easy operation. Clearing all these requirements was the biggest challenge in the development of iArmS," according to Dr.Okamoto.

Basic Design Created by the Engineering Researcher and then Refined by Industrial Engineers

DENSO worked on refining and downsizing the internal structure of EXPERT. "DENSO's painstaking efforts to commercialize the robot and the degree of perfection they achieved are simply amazing. If the braking force were increased in order to stop the robot arm movement firmly, the smooth start of the next movement would be jeopardized. DENSO solved this problem skillfully."

The prototype of iArmS was completed in 2013. It was evaluated highly by 33 doctors engaged in 40 simulated surgical operations. In 2014, iArmS received first prize in the Service Robot category in the Robot Award hosted by the Ministry of Economy, Trade and Industry. The reception of the prize by iArmS was welcome news for the industrial robot industry in Japan.

Dr. Okamoto believes that engineering holds the key to the success of projects that combine Japan's superb medical, engineering, and industrial technologies. "Engineering researchers take charge of creating the base for the commercialization of products that respond to medical needs. The world of engineering is often thought to be founded on originality, but solutions can be created by combining existing technologies, and more often than not the combined approach can better respond to needs. In this regard, it is important for engineering researchers to learn directly from users about ease of product operation and to be informed of the opinion of medical doctors."

The future of surgical robots rests on the shoulders of people who have excellent communication skills and flexible minds that can generate unique ideas.

Keppel DHCS Pte Ltd

Keppel DHCS is known as the largest provider of district heating and cooling systems in Singapore. The company has implemented energy-saving measures at three of its DCS plants in response to stronger national environmental protection measures and in order to reinforce its business competitiveness by reducing operational costs of their facilities. The company has achieved figures well above its preset energy targets while minimizing both investment and risk by adopting an approach of making use of the plants' existing facilities and developing measures based on an ESCO plan.

A Road Map for the Next Decade of Energy Savings Being the Key to Business Success

In the early 19th century, Singapore became UK's trading hub in the East and its prosperity has been based predominantly on the transit trade between India and China taking place there. For some time now, Singapore has been ranked among the top in the world in terms of GDP and continues to grow economically with its high ability to compete in international markets. Keppel Corporation, a government-linked company developing its business in a wide range of industries, such as infrastructure, real estate, marine, and investment, plays a role in Singapore's development. Being a member of such company, Keppel DHCS Pte Ltd is recognized as the largest DHCS*1 provider in Singapore.

Today, Keppel DHCS owns four DCS*1 plants located in four different districts of Changi, Woodlands, Biopolis, and Mediapolis in Singapore. Keppel DHCS has a DHCS plant in Tianjin, China, and is making positive efforts to expand its business in Indonesia and other Southeast Asian regions as well.

In recent years, the Singapore government has been focusing its efforts on promoting energy efficiency in the building field as in industry, and has been working on various initiatives by, for example, implementing the BCA Green Mark Scheme*2 to assess environmentally-friendly buildings.

"The assessment applies to DCS plants, so we had to meet the energy requirements for our plants also. But of course, it is true that implementing energy-saving measures increases efficiency and reduces energy cost, which leads to reinforcement of our business foundations. So from a few years ago, we started to draw up a road map for the next 10 years of energy savings at our DCS plants," says Mr. Ng.

Ideas Incorporating Optimal Control and ESCO Plan in Order to Minimize the Risk of Initial Investment

In the past Keppel DHCS had Azbil's Harmonas-DEO™ central monitoring and control systems installed in all of its DCS plants in Singapore with the support by Azbil Singapore Pte. Ltd. On the background that these systems have contributed to consistent operations and also maintaining the quality of cooling water of these plants, Keppel DHCS requested Azbil Singapore anew for plans to bring about energy savings in line with the road map Keppel DHCS had drawn up.

Azbil Singapore, in response, presented plans using approaches to achieve energy-saving effects by adopting new technologies that enable optimal control of heat source while using existing facilities, such as chillers, cooling towers, and pumps. The presentation also included an ESCO*3 plan that guarantees energy-saving effects.

"In this scenario, we would not have to replace existing facilities with new ones, so we could hold down the initial investment. Moreover, Azbil would guarantee energy-saving effects for five years and a half thanks to the included ESCO plan. Therefore, the plan appeared to be very attractive to us in terms of minimizing risk. It sounded convincing for our parent company, Keppel Corporation, to give us an approval for the plan." says Mr. Ng.

The Harmonas-DEO system for monitoring and control of facilities at the Changi DCS Plant.

Major functions of the utility optimization software package are:
1) Loading operational data from a chilled water plant through a monitoring and control system
2) Predicting the amount of heat load needed by the customer side based on historical demand and climate
3) Controlling chillers, cooling towers, and pumps to produce predicted heat optimally so that the overall energy consumption by these facilities is minimized

Chilled water for air conditioning in the Biopolis business district is supplied from Keppel's DCS plant.

As a starter, Keppel DHCS implemented energy-saving measures to the Woodlands DCS plant, where upgrade of the existing facilities was kept to minimum by, for example, adding VSD (variable speed drive) units to them; and for the rest, a method of optimal control of all heat source facilities was adopted to improve the efficiency of their operations. Specifically, as an addition to the existing Harmonas-DEO system, a new utility optimization software package has been installed for optimal control of all heat source and utility facilities of the plant to meet the heat requirements of consumers and at the same time to minimize the overall electricity cost.

"At first we did not adopt for full automation of the plant operations in order to avoid risk. We were instructing operators to follow the guidance for optimal control of the facilities which is calculated by the optimization system, and there was always human intervention through the central monitoring and control system. However, as we were continuing to operate the plant with the optimization system, we have found the plant's efficiency performance indicated by KPI*4 has increasingly been improved, which we considered to be proof of appropriate operations at all times. After that, we transited to full automation based on utility optimization calculation without human intervention. The optimal control program continuously calculates values and supports plant operations nonstop throughout the year, so we have no worries about achieving energy savings," says Mr. Zaw.

After Achieving Energy Savings Well Above Targets, Keppel Now Implementing Similar Measures to Other DCS Plants

As a result of implementation of energy-saving measures, the Woodlands DCS plant has achieved a large reduction in electricity consumption by 2.28 mil. kW/year, much above its target of about 1.85 mil. kW/year. The achievement rate is 123 % of the target, which is high.

Since the efforts on the Woodlands DCS plant yielded very favorable results, similar measures have subsequently been implemented to the DCS at the Changi and Biopolis plants, which achieved a reduction of electricity consumption, again much above their targets, by over 8 mil. kW/year in total.

"In addition to the eager support by Azbil Singapore in operating the systems, Azbil Corporation remotely monitors our Harmonas-DEO unit and optimization results from Japan to provide support system maintenance and will log on to address problems in case of emergency, so we can feel great peace of mind. The azbil Group has a strong technological background, so we could implement the measures with a feeling of trust," says Mr. Zaw.

"Azbil has helped to train our engineers as well. During the process of the project, our engineers' awareness and skills have been improved through discussions with staff from Azbil Singapore and Azbil Corporation in Japan," says Mr. Keng.

Keppel DHCS will make further efforts to take on energy savings in areas other than DCS plants.

"Our company is engaged in operating chilled water plants for buildings also. We are thinking about constructing a system that enables monitoring and control of multiple heat source control systems operated by different buildings from Keppel Corporation or a special control center. It is an important theme for us to achieve energy savings in this effort as well. From that standpoint also, I think the azbil Group is a very important partner for us to work together in realizing energy savings," says Mr. Ng.

Harmonas-DEO trademarks of Azbil Corporation.

Keppel DHCS Pte Ltd

Location
1 HarbourFront Avenue #05-05 Keppel Bay Tower Singapore 098632

Founded
1998

Business scope
Development, construction, and operation of district heating and cooling systems and facilities.

Joseph Ng
Chief Executive Officer

Poh Tiong Keng
General Manager

Khin Zaw, Ph.D.
Technical Manager

glossary

✻1▶ *District Heating and Cooling System (DHCS)*
District heating and cooling system (DHCS) supplies chilled water, hot water, and steam from a centralized supply facility (plant) to a group of buildings in a district through its underground pipe network for the building's space cooling and heating as well as for hot water supply. This system is also called district cooling system (DCS) in tropical and subtropical regions where heating is not necessary.

✻2▶ *BCA Green Mark Scheme*
BCA Green Mark Scheme is a green building rating system to evaluate buildings' energy efficiency and eco-friendliness operated by the Building & Construction Authority, an agency under the Ministry of National Development in Singapore. There are different levels of rating, including Standard, Gold, Gold plus, and Platinum.

✻3▶ *Energy Service COmpany (ESCO)*
Energy service company (ESCO) provides comprehensive energy solutions for factories and buildings, and the saving is guaranteed by service providers.

✻4▶ *Key Performance Indicator (KPI)*
Key performance indicator (KPI) is a quantifiable measurement that helps to show how well companies, business units, projects, or individuals are performing compared to their strategic goals and objectives.

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At Azbil's major technology development site, a place to build the future together with customers

Celebrating its 110th anniversary in 2016, Azbil is working to increase collaboration and reinforce communication with customers. To that end, Azbil has opened the *azbil Techno Plaza* on the premises of the Fujisawa Technology Center, its major R&D site. The plaza is a place for presenting the technologies and solutions that have shaped today's Azbil, and for interacting with customers to build the future together on the basis of the azbil Group's corporate philosophy of "human-centered automation."

Initiatives to invigorate collaboration in the year of Azbil's 110th anniversary

Azbil, which is celebrating its 110th anniversary in 2016, has been rolling out future-oriented initiatives in various fields in keeping with its corporate philosophy of human-centered automation, which was established in the year of its 100th anniversary. A theme that Azbil particularly emphasizes is communication with customers, local communities, and other stakeholders. The company hopes to raise customer trust and expectations by publicizing its recent R&D efforts in new areas, as well as its long-cultivated technologies and solutions in the areas of measurement and control.

The former showroom situated in the Fujisawa Technology Center (the Group's R&D site) was reborn on June 1, 2016 as the *azbil Techno Plaza*, where visitors can see and experience the azbil Group's cutting-edge automation technologies.

With the remarkable development of technologies like the IoT (Internet of things) and AI (artificial intelligence), companies need innovative viewpoints and approaches in order to create technologies and business opportunities. Azbil believes that collaborative relationships between companies from different industries and between academia, industry, and the government, will make it possible to create new value. The azbil Techno Plaza was established to provide a place to build just such collaborative relationships.

Raising awareness in order to discover issues and paths to value creation

With impetus gained from the opening of the azbil Techno Plaza, Azbil is accelerating collaboration with customers in order to create new value. For that reason the company considers the plaza as a place to discover the challenges faced by customers and as a place for learning.

Based on the concepts of cutting-edge technology, interactivity, and collaboration, the new area provides visitors with opportunities to experience the technologies that Azbil has developed in the past and those that are essential to next-generation products. Since the plaza provides touch-screen monitors to present a variety of content, visitors can directly access the information that interests them. The content will change in response to current areas of strong customer interest and the latest technological information. Information is available in Japanese, English, and Chinese, so customers from overseas can browse through the information after selecting a language on the screen.

The business zone, where visitors can gain an impression of the size and feel of representative products currently in service in the field.

With the Instantaneous Microbial Detection unit system (left) in the collaboration zone, visitors can see the system actually detecting microbes in the water. The highly accurate position sensor system (right) in the same zone demonstrates how a highly precise sensor measures the meander, width, and thickness of a moving film.

The azbil Techno Plaza and other facilities at the R&D site provide tours, for even better communication with customers

The azbil Techno Plaza consists of five zones, broadly speaking. The zone that first comes into view presents the azbil Group's profile and businesses. In addition to information about the Group's production sites in Japan and overseas, the zone also mentions specific approaches Azbil takes to help preserve the environment, and shows the amount of CO_2 emissions that have been cut through the Group's operations so far.

The second zone is the technology zone. Here visitors can learn about the Group's latest technological developments by looking at, for example, a sensor that can measure steam quality, and by viewing sample applications of that kind of device.

The third zone is the business zone, which displays products that represent each of the Group's core businesses: building automation, advanced automation, and life automation. Visitors can see Azbil products that work in the background of critical infrastructure and are therefore rarely seen.

The fourth zone is the theme zone. It emphasizes solutions incorporating technology trends. Currently, the zone displays ICT (information and communication technology)-based products and solutions. For about 30 years, Azbil has provided an integrated building management service. Collecting data on equipment operation, temperature, and humidity from the central monitoring equipment in customers' buildings, this service provides 24-hour remote control over customers' buildings from the Azbil control center. Based on the know-how obtained through providing this service, Azbil has developed a new cloud service for building management. This zone presents the energy management aspect of this new technology.

The fifth zone, which is the collaboration zone, includes demonstrations allowing visitors to experience the cutting-edge technologies Azbil is developing in its strategic technology areas. The demonstrations show visitors device movement up close to allow them to see possibilities for working with Azbil. Currently, visitors can see demos of Azbil's Compliance Actuator and robotic arms that move like human hands, Instantaneous Microbial Detection units that can count microbes in the water or in the air in real time, and highly accurate position sensors that can detect very small and fast changes in position, contributing to quality improvement in the film manufacturing process.

The azbil Techno Plaza is not only a place to gain an impression of Azbil's expanding new product lines and solutions. Major R&D facilities, such as thermal environment testing facilities, valve evaluation facilities, and calibration facilities, are situated in the same location, so visitors can tour them also. Researchers and developers from different fields work in the buildings on the premises, so they can directly communicate with customers, which is an ideal environment for both Azbil workers and customers to learn new things. Visitors to the Fujisawa Technology Center can experience the source of Azbil's technology.

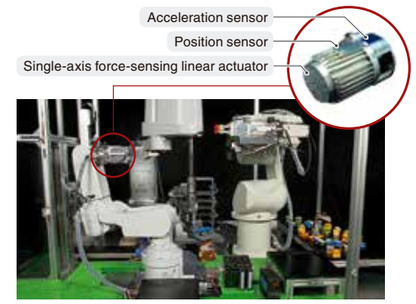
Azbil hopes to improve collaboration with customers through the use of the azbil Techno Plaza, working with customers to build the future based on the Group's corporate philosophy of "human-centered automation."

Column

Robotic solutions with Compliance Actuator technology

In the collaboration zone, there is a demonstration of an automated robotic assembly technology. The device observes a miniature car made from blocks by customers, converts the image into usable data, selects the necessary parts from randomly placed blocks, and then constructs the same miniature car. A Compliance Actuator, with adroit hand-like movement, serves as the heart of this automated robotic assembly system.

The Compliance Actuator consists of sensors for position, acceleration, and electric current, as well as a single-axis force-sensing linear actuator. The robotic arm equipped with this device can adjust the force it exerts according to the hardness of a part, in order to gently fit the part together with another part. It even can make its own evaluation of its performance. Since this system can operate quickly without damaging parts, it is expected to be used for high-mix low volume production, which previously was considered to be difficult to automate using robots.



The Compliance Actuator recognizes a miniature car assembled from blocks by a visitor and selects what it needs from a random scattering of blocks. Making position measurements and precise adjustments of force, the robot arm assembles the same miniature car.

Keywords A to Z Vol.11

Keyword Cloud Computing

Cloud computing offers a way of using computers that makes it possible for you to store and access data and applications (apps) over the internet or another network instead of using your computer's hardware and software. It is also called simply "the cloud."

Development of the Internet Changes the Use of Computers

Today we all use computers in various aspects of our daily activities both at work and at home. We use them to make meeting materials, adjust business meeting schedules, book hotels for family trips, and shop online. It was about 70 years ago when the first computer was invented. Compared with computing hardware at that time, which was so large that a room as big as a school classroom was necessary to store it, today's computers are very small. Today there are many notebook-sized computers that are thin, light, and high-performing.

At around the end of the 20th century, many people began using the Internet and the communication environment began to improve, developments which have changed how computers are used. Today it is common to use computers online rather than using them disconnected from the Internet. With the advent of devices like smartphones and tablets, anyone can easily use computers anytime and anywhere.

We Use the Cloud without even Knowing It

When we want to create something using the computer, we first have to install a suitable application, such as a word-processing application or graphic design software. As a result, our computers are usually loaded with multiple applications and the data we have created using them.

However, in recent years, a service freeing us from installing applications on our computers has made its way into our daily lives. This service allows us to access and use applications provided over the Internet and also to store the created data on the Internet. This is one example of using *cloud computing*. The word *cloud* we increasingly hear today is an abbreviated way of saying cloud computing.

In fact, we have been using cloud services for quite some time without even knowing it. Online search engines are one example. We use our computers to access search engines on the Internet and obtain information from them. Webmail* services and file-sharing services available for free are also examples of cloud services.

Cloud Services are Increasingly Used for Their Availability and Convenience

The Internet is like a web of connections of many computers. We can receive various cloud services through this network crisscrossing cyberspace.

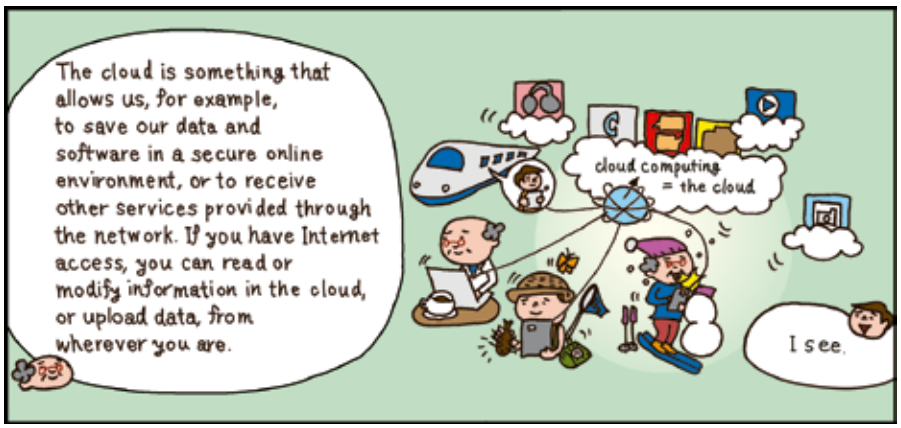
With cloud computing, both applications and data are on the Internet. If you have a device like a smartphone that is connected to the Internet, you can accomplish necessary tasks anytime, even in the train or in a cafe. We can do the same thing without using cloud services, for example by installing a computer and constructing a system for it at the company, but that requires labor and cost. Also, periodic maintenance, such as updating applications to correct program errors, is needed, but in the case of the cloud, a cloud service administrator does an update, so each user does not have to do it individually, which saves both time and effort.

Because of these advantages, cloud computing is now becoming increasingly widespread. For example, in the area of building management, cloud service for sharing building operation data online has appeared. Previously, data on electricity or natural gas consumption was only available to staff working in the central monitoring room of the building. However, using this cloud service, the information can be checked in real time, without being on-site, using a smartphone or tablet.

In addition, collectively managing information in the cloud that was gathered from multiple buildings can lead to more efficient energy management operations through the use of comparative analysis, so information obtained daily can be used even more effectively. Also, information such as the work logs of building managers can be stored in the cloud, allowing it to be shared easily.

It is expected that if everyone involved can access relevant energy information when they need, energy-saving awareness throughout the entire building will increase. In the future, as cloud computing technology develops further, we will have even easier access to various services that will make our daily lives ever more convenient.

* Webmail or web-based e-mail is a mail service running on a web site. It is accessed from a web browser, without any special e-mail software. Old e-mail and the user's address book are stored in the cloud.



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Azbil's cloud service for building management provides energy management, efficient facility operation management, and reduced management costs. Since users can check information regardless of time and place, everyone involved has better information access.

Cover photo by Koji Mizutani, MERRY PROJECT Representative

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Yamatake Corporation changed its name to Azbil Corporation on April 1, 2012.

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