



# The Robot & AI Revolution I

## Robots will Change Work & Industry

Editorial team, *DIAMOND WEEKLY*

*Robots exist as a substitute for humans, and are sometimes perceived as a job-stealing threat. But in reality, they are not necessarily our rivals. In the real-life workplaces where robots have been introduced, there are also hidden hints for coexistence.*

**I**t has two eyes on its flat head. It cannot walk with two legs, but it has two triple-jointed arms—with shoulders, elbows and wrists—that it can move freely... The external appearance of NEXTAGE, a robot developed by Kawada Industries, is totally different from that of the clunky-looking industrial robots that have seen popular widespread use in Japan until now.

The difference is not only in its appearance. In contrast to conventional industrial robots, which pride themselves on speed and power, and operate under the assumption that human beings will not go near them, NEXTAGE aims to coexist with humans. It's not merely a piece of 'equipment,' but a 'partner.'

But Kawada Industries didn't develop NEXTAGE simply to give it a friendly appearance and try to create a nicer atmosphere on the production floor. There is a genuine business opportunity behind it.

Japanese manufacturing is not based solely on factories filled with lines of high-powered industrial robots. Factories such as those that produce a diverse range of products in small quantities, or make products with high added value and a short product lifecycle, have come to depend on human hands, which allow flexible changes in the content of the assigned task.

Setting its eyes on this niche, Kawada Industries developed a robot that could gain entry to the production lines where humans work.

GLORY, a manufacturer of currency-counters and other machines, has installed 18 NEXTAGE units in its Saitama factory. On one of the production lines there are 4 NEXTAGE units, and only the final process is handled by a human. In other words, 4 out of 5 jobs are handled by a robot.

This is NEXTAGE's true merit. By adopting a humanoid design and being the same size as a human, it allows people to go near it and around it. In addition, the content of its task is freely programmable via an application by the company where it is installed. This means that, in other words, it can substitute for humans in handling processes that are usually handled by human workers.

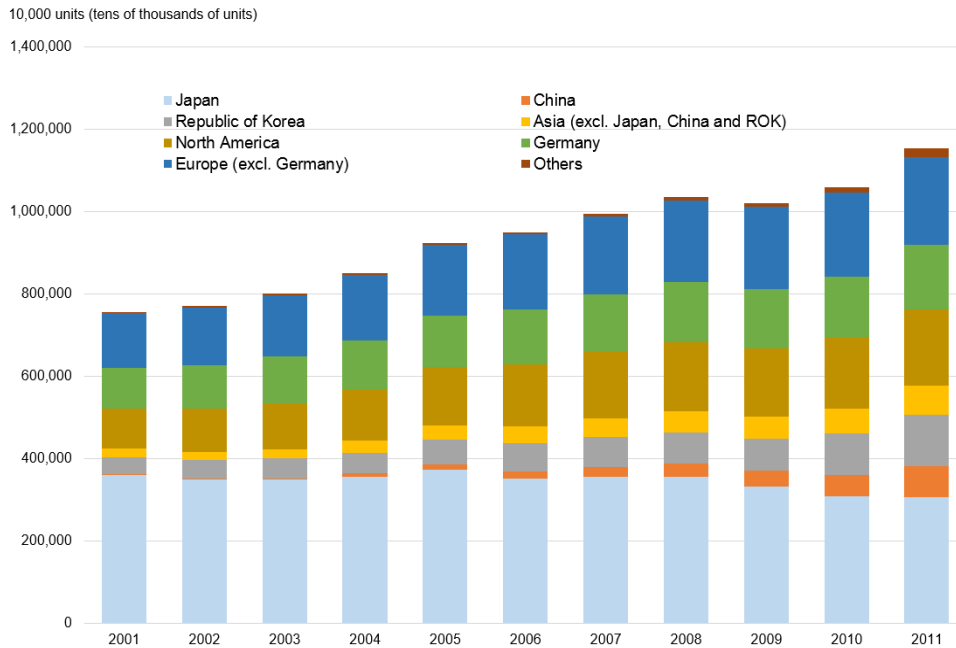
Care was given to its design. In order for a robot to successfully infiltrate amongst human beings, it must not make the surrounding humans feel tense or nervous. As a result, the robot has a friendly and approachable feel to it; like its elliptically shaped head section, for example. Care has also been given to safety, deliberately giving the robot's arms a curved shape so as not to trap the fingers of their human co-workers.

Something interesting is taking place at the companies where NEXTAGE has been introduced. They say that, because of their endearing aura, almost without exception the robots are being given names by the (human) employees. These are not typical robot-style names. As Shiroma Naohito, Director at Kawada Robotics says, "foreign-style or Japanese style, male or female...the naming-rules differ from company to company," so it's clear to see that these robots are being welcomed with affection.



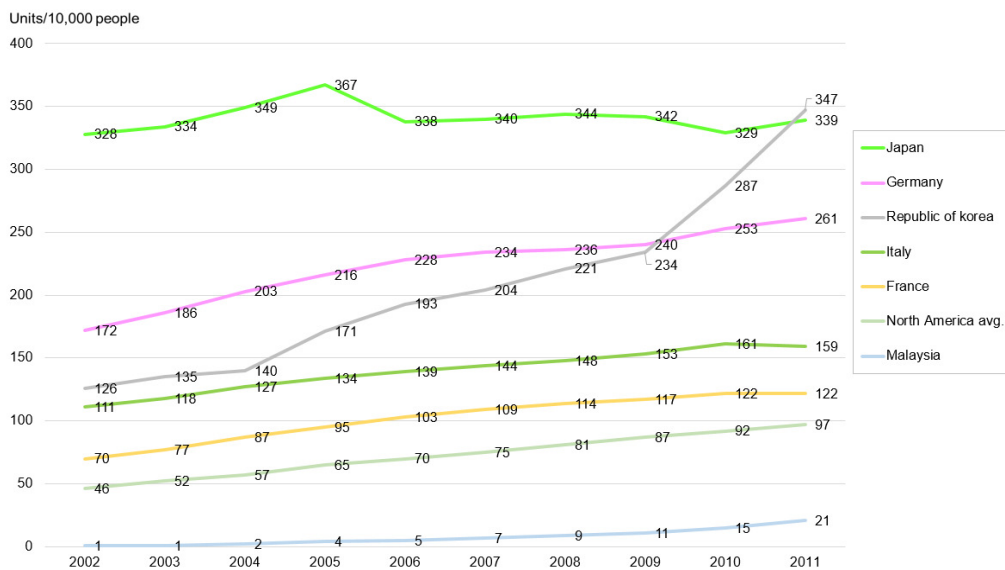
## Japan is already a robot superpower

Fig. 1: Number of Industrial Robots in Operation in Major Countries & Regions



Source: Ministry of Economy, Trade and Industry (METI)

Fig. 2: Number of Industrial Robots per every 10,000 Manufacturing Industry Workers in Major Countries & Regions



Source: Ministry of Economy, Trade and Industry (METI)



The current price tag of the NEXTAGE, which has now sold more than 150 units, is ¥7.4 million. If the price is lowered, it is possible that it may also be introduced into small-scale local factories in the future.

The manufacture of industrial robots in Japan began during the 1960s, and Japan leads the world in terms of both production volume and prevalence of use (see figures 1 and 2). Conversely, and possibly because of this, it is being pointed out that domestic demand for industrial robots in Japan has peaked. However, that doesn't refer to these new kinds of robots that coexist with humans.

While these robots are capable of substituting for some tasks that humans do, says Director Shiroma, "there is no way that NEXTAGE—which is incapable of thinking for itself and performing kaizen (improvements)—will steal the jobs of humans."

If NEXTAGE's challenge in aiming for coexistence with humans is successful, then the spread of robots in the manufacturing workplace may enter a new dimension.

### **Already performing outstandingly, in rehabilitation and cancer surgery**

"To begin with I thought that even if I didn't do anything the robot would just make me walk on its own, but actually its sort of like a little bitty sports gym."

Mr. Sato Koichi (alias) says that, due to an accident, at one point he was unable to move any part of his whole body except for the tip of his left foot. What he has been continuing everyday recently as part of his rehabilitation is a training menu that incorporates the robot suit, HAL®.\*

HAL is a wearable robot, developed by the University of Tsukuba venture company, CYBERDYNE. By sensing the faint bioelectrical signals that flow through the surface of a the skin when a person tries to move their muscles, HAL helps to move the relevant body part in support of those muscles. Over approximately 400 HAL units are already in use in care and rehabilitation facilities across Japan.

Mr. Sato moves from his wheelchair to sit on a bench, where patches for sending the bio-potential signals from inside his body to the robot are attached to his body, and HAL is fitted to both of his legs. For around 10 minutes he remains seated in this position, doing a type of training in which he lifts his legs up one at a time, borrowing the power of HAL's 'assist' functionality.

After putting on HAL—and with physiotherapist Dr. Kojima Masayuki monitoring his center of balance and the distribution of power during exercise via the screen of his laptop computer— Mr. Sato lifts each leg 100 times, and then another 30 times while Dr. Kojima applies weight with his hand. It's quite vigorous exercise, and Mr. Sato's forehead is dripping with sweat.

Towards the end of the 1-hour training session, they also do training to stand up wearing HAL. You can see the standing movement becoming smoother and smoother with each repetition.

"Because the power of the assist changes depending on your physical condition, I can tell how I'm doing that day, and even after I take the robot off, the sensation of being able to move stays in my legs. For me it's an important form of rehabilitation," says Mr. Sato, who is feeling the benefits of HAL first-hand.

A similar scene could also be seen next door to where Mr. Sato was continuing his training, with patients putting on HAL suits and engaging in training one after another. They say that virtually all members of staff are capable of handling HAL with no problems. Here, 'robots' are an everyday sight.

This Lion Heart Clinic (in Chiba Prefecture), which utilizes HAL for rehabilitation therapy, introduced 3 HAL units around 3 years ago. The beneficial effects have been tremendous; with paralytic spinal injury patients becoming able to stand for the first time in several years, or becoming able to relieve themselves on their own.

"The benefits of being able to perform rehabilitation in an upright position—even with patients who cannot stand—are significant, in terms of developing their core too. We hold workshops with the staff every month on how to use it, and have no concerns about the robots themselves. On the



contrary, we really feel that they are a tool that enables us to conduct rehabilitation safely,” says Dr. Kojima.

“Just when we were feeling that we had reached the limits of treatment for patients left paralyzed or functionally impaired by strokes, HAL has provided us with significant possibilities. Seeing the patients rejoice is also a source of motivation for the staff, and they come up with lots of ideas for things they’d like to try using HAL,” says Numada Jin, director of the Ryokuyukai Medical Corporation, who runs the clinic.

Currently an average of around 6 people use HAL per day. Director Numada says he would eventually like to increase that number to around 20 at Lion Heart Clinic, and also to utilize HAL at the short-stay care facility that he runs in conjunction with the clinic.

Meanwhile, on the medical treatment front, the introduction of surgical support robots is progressing.

US company Intuitive Surgical, Inc.’s da Vinci® is a remote-control surgical robot. The surgeon conducting the operation sits at a console some distance away from the patient, and operates the hand-held controls, while freely magnifying the image of the patient’s surgical site projected on the 3D viewer. In conjunction with the surgeon’s hand movements, the robot arms ‘take up the scalpel’ and carry out the operation. Because the system is equipped with a function to correct hand tremors it is said to be more precise than the surgeons actual hands.

Dr. Uyama Ichiro, professor of gastroenterological surgery at Fujita Health University Hospital, is a famous surgical doctor who was the first in the world to successfully perform the total removal of a stomach by laparoscopic (minimally invasive) surgery. He is also famous for being asked for by name to be the surgeon to perform baseball player and manager Oh Sadaharu’s stomach cancer operation.

“I have performed almost 1,000 laparoscopic operations, but the ones I do with the robot are the highest quality, and most importantly are easy to perform. Since I turned 50, I can’t do without my astigmatic and bifocal glasses. The existence of a robot that allows me to zoom in and see as if I were looking through a magnifying glass is something I’m very grateful for,” he reveals.

Dr. Uyama introduced the da Vinci at the end of 2008, and performed his first operation with it in 2009. He has now carried out over 180 robotic surgeries, and is Japan’s leading authority in the field.

Even veteran surgeon Dr. Uyama admits, “The robot is more precise than my own hands.” Da Vinci is capable of folding a 1cm<sup>2</sup> piece of origami paper.

According to Dr. Uyama, his peak for performing what are for a doctor simple manual techniques, such as cutting and removing diseased areas, was when he was around 35–36 years old. Since then, as he prides himself in saying, he has maintained overall quality by accumulating experience, but reveals that his delicate sense of feel is deteriorating. From his own experience, the professor considers that, “because using the robot allows you to maintain the delicate sense of touch of you peak years for longer, I think that it will enable us to extend the ‘lifespan’ of surgeons.”

As much as robots make the work of humans more convenient, fingers are pointing at the possibility of them taking jobs from humans too. The debate over ‘competition with the machines’ is particularly heated in the US.

However, the cases raised here show how robots can coexist with humans, or maybe even tell us how robots are playing a part doing something that humans could not have offered in the first place.



# The Robot & AI Revolution II Can We Win on the World Stage? Japan's Road to Survival

Editorial team, *DIAMOND WEEKLY*

*Lifestyle support robots: they're raised as a key element of Prime Minister Abe's economic growth strategy. A Japan-originated international safety standard has been published, and a whole line of national projects is in the works. But what's really necessary to launch them as an industry?*

On February 1, 2014, an international standard was quietly born. ISO13482: an international safety standard for lifestyle support robots. The news that a new ISO standard had been officially published appeared quietly on the inside pages of newspapers and in short reports in trade magazines, but it didn't capture the attention of the masses.

But the establishment of this standard was also the fulfillment of a long-held wish for Japan. Because while until now almost every international standard had been established under the controlling grasp of the USA and Europe, for pretty much the first time ever, the establishment of this standard was led under the initiative of Japan. And furthermore, because it is an ISO standard that holds the key to a market that is anticipated to grow substantially in the future.

Lifestyle support robots: raised by Prime Minister Abe Shinzo as part of his economic growth strategy. The term refers to robots—excluding industrial-use robots—that are used in the human living space, such as in home nursing care and medical treatment/healthcare.

According to estimates by the Ministry of Economy, Trade and Industry (METI), the size of the market for service sector robots, which currently only amounts to around ¥60 billion including services such as dispensary support at pharmacies, security and logistics applications, is projected to grow to ¥370 billion in 2015, and grow to as far as ¥2.6 trillion by 2025 (see figure 3).

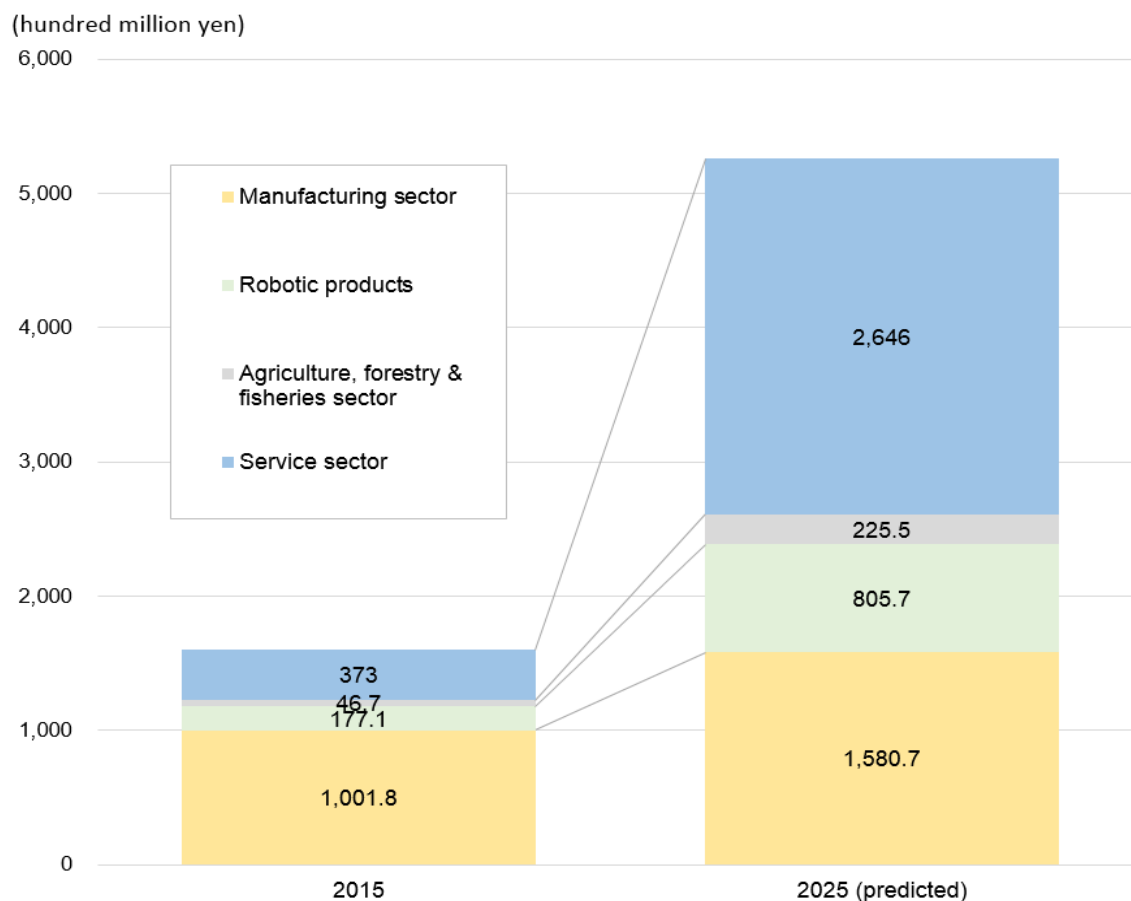
What was considered necessary for popularizing these kinds of robots was a 'safety standard.' If by any chance a regular person were to be harmed by a robot when using it in their daily life, there is a risk that the brand of the company that manufactured it could be severely damaged as a result. Many companies hesitated about commercializing their robots because they were afraid of this risk.

It took almost 9 years to achieve the establishment of a safety standard for lifestyle support robots. At any rate, the committee meeting for discussing the establishment of the standard began in 2006. The deliberations ran into difficulties over the as yet non-existent market. But, as Asada Sumio, director of Development and Promotion of Certification Systems at the Japanese Quality Assurance Organization (JQA), who participated in the meetings as a project member reflects, "At the time, the only ones in possession of prototypes were Japanese companies, and as a result of that the Japanese members were able to make the most concrete remarks, and lead the debate."

Out of the wide variety of lifestyle support robots, it was decided that ISO 13482 would deal with three types: mobile type robots that move autonomously, wearable type robots that are worn by the user, and ride-able types that carry people.

In addition, Japan took the lead in proposing and creating not only measures relating to the products themselves, such as a unique risk assessment method different from that used for motor vehicles and electrical equipment and a quality control framework for at the time of mass production, but also methods for gaining access and conducting assessments from the conceptualization and product design management framework stages of robot development.

**Fig. 3: A ¥5 Trillion Market by 2025  
Predictions for the Robot Market**



**Source:** Ministry of Economy, Trade and Industry (METI)

Personal mobility	¥884.3 billion
Logistics	¥314.8 billion
Checks & maintenance	¥234.5 billion
Health management	¥201.6 billion
Security	¥195.2 billion
Hobbies	¥148.5 billion
Care & welfare	¥123.9 billion
Medical/healthcare	¥70.0 billion





Currently JQA is the only organization conducting ISO certifications for this standard. So far, since the official publication of the standard in February, certification has been obtained by three companies—all of them Japanese: CYBERDYNE, Panasonic and Daifuku. It truly lives up to its name as a ‘Japan-originated international standard.’

## 9.4 million ¥100,000 nursing care robots in widespread use by 2025!

Japan’s Ministry of Economy, Trade and Industry (METI) has been hammering out robot related national projects in quick succession over the last few years (see table 1).

### Injecting State Funds under the Theme of ‘Low cost, High Volume Propagation’

**Table 1: The Japanese government’s recent robot development-related national projects**

Name	Overview	Results / Objectives
(FY2009-2013) Project for Practical Applications of Service Robots ¥7.4 billion	<ul style="list-style-type: none"> <li>• Establishment of a human safety standard, testing and certification methods for lifestyle support robots</li> <li>• Development of robots equipped with safety technologies</li> <li>• Proposal of the international standardization of the safety standard, and development of testing and certification institutions</li> </ul>	A Japan-originated international safety standard for lifestyle support robots ISO13482 was formulated, and published in February 2014 → CYBERDYNE, Panasonic and Daifuku obtain certification
(FY2013 onwards) Project to Promote the Development and Introduction of Robotic Devices for Nursing Care FY2013: ¥2.39 billion FY2014: ¥2.55 billion	<ul style="list-style-type: none"> <li>• Support for the development of nursing care robots with emphasis on five priority areas: transfer/lifting aids, mobility support, toilet support, monitoring systems for people with senile dementia &amp; bathing support</li> </ul>	To promote the introduction of 9.4 million nursing care robots by the year 2025 (appropriated amongst 7 million households of elderly people living alone and 2.4 million professional caregivers), narrowed down to essential functions and costing approximately ¥100,000 each.
(FY2014) Project for the Introduction and Validation of Robotic Devices for Nursing Care FY2013 amendment: ¥2.05 billion	<ul style="list-style-type: none"> <li>• Support for the large-scale introduction &amp; validation of nursing care robots into actual care sites</li> <li>• Full financial support for costs incurred by intermediaries that mediate between manufacturers and care facilities, conduct courses and give feedback etc.</li> </ul>	
(FY2014-2015) Project to Develop Systems for Handling Social Issues such as Infrastructure Maintenance, Management and Renewal FY2014: ¥2.22 billion	<ul style="list-style-type: none"> <li>• Maintenance and management (bridges, tunnels, rivers &amp; dams) and disaster response (investigation of disaster situation, emergency recovery) etc.</li> </ul>	Validation testing on infrastructure under the direct jurisdiction of MLIT (Ministry of Land, Infrastructure, Transport and Tourism) during FY2014, full scale introduction and operation of completed systems by FY2017



They have determined a safety standard for lifestyle support robots, translated it into an ISO standard, and built a Robot Safety Center in Tsukuba City, Ibaraki Prefecture, that can conduct safety verification testing on robots before they are actually productized.

When this project ended at the end of in FY2013, they started a project for developing robotic devices for nursing care. The ambitious target set for this project was to promote the introduction of 9.4 million care robots, narrowed down to essential functions and costing around ¥100,000 each, by the year 2025. The figure of 9.4 million equates to the predicted 7 million households of single elderly people living alone, and the 2.4 million caregivers that will be required by 2025.

“Until now, robots possessed multiple advanced capabilities, and their prices also tended to be high. But highly priced robots will not be accepted by the nursing care industry. We set the price of ¥100,000 as the benchmark that we should aim for at the popularization stage,” says Kitashima Akifumi, deputy director of METI’s Industrial Machinery division.

Over the next 5 years, METI will carry out intensive development and activities to promote the widespread use of these robots. The subject topics include lifting aids for moving patients from beds to wheelchairs etc., electrically powered cart-type devices that provide walking/mobility assistance, sensors for monitoring dementia patients and so on—none of which look or sound particularly robot-like.

In addition, a development project for robots that monitor the condition of aging infrastructure such as bridges and tunnels, disaster response robots and so on is also to be added. In FY2013 and FY2014 alone, a total of ¥10.4 billion of state funding was allotted to these projects for the development and popularization of lifestyle support robots.

“There’s also the fact that these robots were made a key feature of the government’s growth strategy...but at any rate, there are so many projects running around right now that you can’t keep track of them. It’s like they’ve got a little festival going on over at METI,” says one robot industry affiliate, laughing wryly.

Preparing the ISO standard and certification framework in anticipation of the spread of lifestyle support robots, and purposefully not chasing after the latest technologies, but putting out large numbers of robots with narrowed-down functionality, with the objective of promoting wide spread use. Not only that, but narrowing down development to areas such as nursing care and infrastructure maintenance, areas which in the near future it will surely become impossible to cover with human manpower... This is the kind of direction that the Japanese government is aiming for right now. It’s unusual for the government to raise specific targets for prices or numbers of units, or specific themes for development when creating a national program, but it’s probably fair to say that this is a sign of their intention to turn robots into a full blown industry, whatever it may take.

But the situation is not so simple that robots can be turned into an industry with just these policy measures alone.

First of all, there is the big question mark as to whether there is actually a demand now for robots at the care facilities that are regarded as being such a promising market.

“At this current stage, it’s tough for existing facilities that have been performing their services without relying on robots to suddenly change the way they work, and the demand to introduce robots is too sparse to force the issue. Even in the case of transfer assistance (i.e. transferring patients from beds to wheelchairs etc.), which places a burden on caregivers—if they have time to be putting on a muscle suit every time, there are many cases where it’s faster to quickly go and call another person and do it together,” says Sekiguchi Shiro, director of the Nursing Care Robot Promotion Division of the Kanagawa Welfare Service Association, which conducts projects to promote the spread of nursing care robots.

He says that cases where care facilities are lent the robots on a trial basis etc., at almost no charge, but in the end the robots are left virtually unused and just gathering dust are not uncommon. “Each facility needs to have the kind of human resources that can coordinate how robots can be utilized in the course of duties and arranged around the workflow.” (Director Sekiguchi)

In fact, starting from this fiscal year, METI started the Project for the Introduction and Validation of Robotic Devices for Nursing Care, which performs this kind of matching of intermediaries that go between robot manufacturers and care facilities, advising them on ways of utilizing the robots





etc., fully subsidizing the effective costs of courses and so on provided by the intermediaries. But even with this, the manufacturers first have to go out on their own to find facilities that are willing to use their care devices.

Towards the spread and popularization of robots, it is also necessary to introduce the kind of legislation that will encourage their use. In actual fact, in countries such as Australia, for example, it is obligated by law that when workers engaged in caregiving have to lift a person up consideration must be given to ensure that excessive burden is not placed on the body of the caregiver during the course of their duties, by always using a lift or such device. Unless we create a framework in which it is easy to use robots—either by making it the same in Japan, or by making nursing care insurance applicable etc.—then it won't easily lead to motivation on the part of nursing care facilities to utilize them.

The issue of a Japan-originated ISO and the existence of various national programs and so on will surely give a boost to the industrialization of robots. But surely in the end, what is necessary for robots to take root as an industry lies in the single point of 'making something that fits the needs of the user.'

### **SECOM: knows the automation of its own services inside-out**

In that sense, the example of SECOM, which despite not even being a robot manufacturer is developing robots in-house and naturally incorporating them into its operations "according to business needs," may serve as a helpful reference.

SECOM is a company that has expanded its security business even without increasing manpower from the beginning anyway, by the mechanization of security. "Because we conduct our business ourselves, we are intimately familiar with which points among our company's services are more efficient if they are automated rather than having people do them, and which parts are better left in the hands of humans, and how best to combine those two," says Komatsuzaki Tsuneo, managing executive of SECOM who is also director of the robot-developing Intelligent Systems Lab (ISL).

For example, what has become common practice to use for security at locations such as factories, or commercial facilities after they close, is Robot X. Robot X spots fine differences from the previous patrol round that human eyes are poor at spotting, senses abnormalities or thefts etc. and alerts the resident security guard. By conducting patrols that were until then carried out by security guards, it has become possible to detect small abnormalities. For example, just one cardboard box being missing from a pile of loaded boxes.

A helicopter security system that is currently under development, and scheduled to enter service next fiscal year, automatically takes off from its on-site hanger when sensors at the entrance to the premises detect an illegal intrusion. It then tracks down and approaches the intruder, and records video footage of them. It tracks intruders even if they enter the surveillance camera blind spots, and alerts the security/guard center and police etc. in real time. The aim is to link this to early-stage arrests of perpetrators, deterrence of re-offenders and so on. SECOM says that it plans to add the helicopter as an added service for existing customers who already have a contract with SECOM at an extra charge of ¥5,000 per month. The official start date for the service is not yet decided, but they say that reservations are already flooding in.

### **We don't need technology-oriented robots that don't consider the 'outlet'**

In order to create lifestyle support robots that will be truly accepted, it will be necessary to get into the workplace of the service into which we are trying to introduce the robot, from the conceptualization stage, and to identify what tasks among the daily duties of that business would be most suitable to entrust to a robot.



In that sense, saying “Ok, we’ve made something good, so now let’s go and find somewhere that will use it,” after the robot is already completed is too late. If we are seriously going to aim for the widespread popularization of robots rooted in everyday life, then the technology-oriented way of thinking won’t work.

If we grasp the needs of the customer, then cutting-edge technology is not necessarily required. For example, take the case of the ‘grandchild robot’ Ma-Kun that was developed to meet the needs of elderly people living alone who want someone to talk too. It talks to itself out loud every 20 minutes; in the morning saying “Let’s open the window,” in the evening asking “Did you go shopping?” For solitary elderly people leading a life where they may go several days without speaking to anyone, even this is enough to stimulate a conversation. On birthdays and seasonal events it even sings songs to the user. It can only recognize 19 words, but is also capable of reciprocal conversation. The current model has sold 3,000 units since last November by mail order via the maker’s own website alone, and including the previous model around 90,000 have been sold so far in total.

“There are people who repeatedly call to say thank you, or send gifts of Japanese pickles and so on. They make clothes by hand and dress it up in them, and take it on holiday with them too. There are many people who even say they want it to be placed in their grave with them,” says Morita Shinji, president of Partners Inc., the company that sells Ma-Kun.

As to the reason why robots have not grown into an industry in Japan so far, Dr. Hirukawa Hirohisa, director of the Intelligent Systems Research division at the National Institute of Advanced Industrial Science and Technology (AIST) says “It’s because we’ve kept making useless things. Because there was a lot of research conducted where they weren’t thinking seriously about the ‘outlet’.”

The list of robots that never see the light of day as far as practical realization is too long to mention. Sony, once known for its robots AIBO, Qrio and so on, sold off its robotics division to the Toyota Motor Corporation. At Toyota too, robots have yet to be turned into a business.

Japan has over 30 years of robot development history. To take advantage of the golden opportunity of a Japanese-originated international standard and take the lead on the world stage, it might be necessary for Japan to go back to the basics of manufacturing once again: make what the customer wants.

*Translated from “Robotto ga Kaeru ‘Sangyo to Shigoto’ (Robots will Change Work & Industry)” and “Sekai de Kateruka? Nihon no Ikiru Michi (Robots will Change Work & Industry — Can We Win on the World Stage? Japan’s Road to Survival),” DAIMOND WEEKLY, 14 June 2014, p.40-42, 50-53. (Courtesy of DIAMOND, Inc.) [June 2014]*

\* Related articles on HAL:

Helping Japan Win in Both Technology and Business, Editor's blog, Jun 05, 2014, Discuss Japan  
<http://www.japanpolicyforum.jp/en/archives/editor/pt20140605001053.html>

Global Companies from Japan, Economy, No.17, Discuss Japan  
<http://www.japanpolicyforum.jp/en/archives/economy/pt20131125174131.html>

---

Editorial team, *DIAMONDWEEKLY*

---