

THE ART OF MANUFACTURING



ものづくり

monozukuri

ISSUE 5

Mitsubishi Electric Factory Automation Customer Magazine



AUTOMATING THE WORLD

A new direction for
Mitsubishi Electric

FUTURE TECHNOLOGY

Latest news from the
Advanced Technology
R&D Center

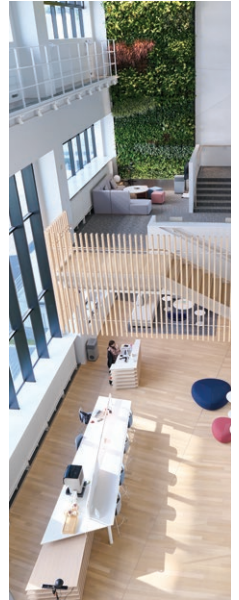
PASSION ROAD

Commitment to quality
at every level

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Providing tips to solve manufacturing issues and the latest trends in Mitsubishi Electric Factory Automation. Please follow us.

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The story behind Automating the World

Life has become more complex and to some degree more confusing. Manufacturing, and from a larger perspective Society, has gone through huge challenges and resultant changes.

The most impactful have been the rapid adoption of digitalization, the pressing need to become “sustainable” in all aspects from energy consumption to pollution reduction, and the need to cope with shrinking populations in many nations.

Despite all these changes it's comforting to know that there are companies and partners you can rely on. Mitsubishi Electric has consistently focused on creating “Changes for the Better” for a vibrant and sustainable society through continuous technological innovation and ceaseless creativity, and its Factory Automation team are proudly finding new ways through the application of advanced technology, sharing know how and actively collaborating with one goal, to apply and utilize automation for the betterment of all. This is why we want to clearly state in our slogan, “Automating the world”, that we are not only helping a world of industries, but also a world of society to apply automation for everyone's greater benefit.

Mitsubishi Electric; “Automating the World” to create “Changes for the Better” for all. ■

Naomi Nakamura,
General Manager,
FA Digital Marketing Center



Automating the World

Taking people beyond their boundaries

'Automating the World' is so much more than an aspirational slogan. It is a vision sourced from the voices of our global stakeholders to demonstrate how Mitsubishi Electric Factory Automation's advanced technology, systematic thinking and customer support can work to make a better, more sustainable world for all.

When we automate the handling of dangerous processes, we are helping reduce risks to human health and wellbeing. When we automate activities to reduce waste, pollution, energy consumption we are helping to create a decarbonized, more environmentally sustainable society. And when we automate complex, often difficult processes, we are helping to transform lives by enabling people to participate and contribute more actively and more meaningfully than ever before.

Automation changes the world for the better

Today's automation technologies can make things work better in every single area of activity, from design and planning to production, maintenance and customer support, enabling such benefits as increased reliability, wider choice, and shorter delivery times. Mitsubishi Electric's medium-term business strategy to the fiscal year ending March 2026, is to implement strategies to grow its factory automation systems business, providing intelligent manufacturing solutions that will enable customers to transform their businesses. Our strategies may change, but our corporate vision of 'Changes for the Better' remains a constant through all that we do.

Interestingly, 'Changes for the Better' has a strong link to traditional culture and the Japanese concept of Kaizen, a word which references the process of those constant, incremental changes which contribute to continuous enhancement and improvement. Looking at the recent 100th anniversary of Mitsubishi Electric, it is easy to see how 'Changes for the Better' and the meaning of Kaizen underpins not just our success, but that of most other businesses.

Automation of factory processes enhances lives in quite discernible ways. The challenge of an ageing population is a useful illustration of the power of automation, which can help overcome the associated loss of knowledge and experience while also addressing the issue of shortages of skilled staff.



LOGISTICS ROUTE

NETWORK : REAL-TIME



- Multi-modal
- Multi-user





Mitsubishi Electric utilizes digital technology to connect the entire manufacturing life cycle with the aim of optimal and flexible manufacturing to address uncertainty.

It's sometimes hard to conceive the sheer volume of change that has taken place in the past 100 years or so – and it's equally difficult to appreciate the broader social benefits that these changes have brought. Since the time of the first industrial revolution, the biggest of these changes have been in such things as the application of technical know-how, innovation, and breakthrough research and development – not just in manufacturing, but in all aspects of society.

The pace of that change has increasingly almost exponentially since then, bringing even greater social and business pressures with it, all compounded by the issues around a global pandemic, the growing need for decarbonizing across the board, the effects of an ageing society and the dynamics of a global economy which is driven by ever greater levels of competition.

Automation is continuing to revolutionize the world of machines and work. Today, more than 50 years after Neil Armstrong took that first historic first step onto the surface of the moon, we see spacecraft docking into the International Space Station with no assistance from the astronauts inside them. Such is the power of automation machine technology, now deployed in new environments, to free individuals from time-consuming, repetitive tasks and enable them to focus on more appropriate and more fulfilling activities.

Labor shortages and rising labor costs are challenges being faced by manufacturers around the world. From raw materials to the supply, manufacture and distribution, organizations are being asked to do more with less. And to do it with greater efficiency. The answer to all of these issues lies in the adoption of automation.

Robotic Process Automation environments featuring inventory robots, self-drive forklifts and collaborative robots working safely and in harmony with people, can address labor shortage issues and driving improvement efficiencies to previously undreamed of levels.



Automation for sustainability

In recent years, global society has been compelled to adapt to the growing needs for work efficiency, digitalization and decarbonization. The automation of activities that reduce waste, pollution and energy consumption is vitally important to the building of a decarbonized, more environmentally sustainable society.

Automation can be harnessed in all sorts of ways to help address the many sustainability issues around the globe and the end goal must always be to improve the quality of life for all the world's citizens by mitigating all that is threatening or damaging, embedding processes and solutions that are resilient and future-proof. Securing a better future for all means having sustainability at the very heart of all business objectives and operations.

In all of this, smart technologies such as IoT, AI, ML and NLP have a vital role to play. Mitsubishi Electric Factory Automation, in partnership with our customers and wider society, is rising to these challenges.

The company Environmental Sustainability Vision 2050 recognises that it is the responsibility of all corporations to make a long-term commitment to solving global environmental issues. The vision document outlines these three broad Environmental Action Guidelines:

- Apply diverse technologies in wide-ranging business areas to the solution of environmental issues
- Meet the challenge of developing business innovations for future generations
- Publicize and share new values and lifestyles



“The Smart Society” is about creating better futures for all by bringing together a range of innovative technologies including zero-energy buildings (ZEBs), the Internet of Things (IoT) and artificial intelligence (AI) as well as machine learning, data analytics, satellite communications, mobile connectivity and robotics. Maximizing the implementation of transformative technologies is the key to developing sustainable economies will also revolutionize the job market and the world of work.

Mitsubishi Electric is focusing this integrative solutions programme around four thematic areas:

Life – covering energy-efficient technologies and eco-friendly solutions such as ZEBs and non-contact solutions for business and home use.

Industry – covering such labor-saving and productivity-enhancing industry solutions as robots and e@factory solutions.

Infrastructure – covering renewable power generation, AI-based monitoring solutions and public transportation systems that provide sustainability, safety and security.

Mobility – covering autonomous driving, driver monitoring and mobility robots that can take on a multitude of tasks like delivery, security and professional services.

The vision is for a seamless and holistic integration of connected products weaving a connected fabric of intelligent data to make everyone safer, more productive and more energy efficient. In this landscape, smart ecosystems enhance the quality of people's lives by connecting transportation to infrastructure, industry to business and robots to humans. The ultimate benefit will be the delivery of energy-saving, health monitoring, disease prevention and mobility strategies for safer transportation.

Improved sustainability through ‘joined up’ maintenance

In today's fast-evolving business environment, the impact of sudden equipment downtime on corporate profits can be crippling. For manufacturers, the consequences can be profound and potentially disastrous, amounting to billions of dollars in lost revenue and increasing global competition is only adding to that pressure. The growing need to increase machine availability in order manage maintenance and maximise reliable production is leading more and more businesses to look at planned equipment maintenance systems and integrated maintenance solutions.

These solutions usually comprise predictive maintenance (preventing problems before they arise), preventive maintenance (managing data to enable planned maintenance) and corrective maintenance (utilizing historical data to shorten investigative time).

Smart Condition Monitoring from Mitsubishi Electric

The Smart Condition Monitoring (SCM) solution from Mitsubishi Electric provides a complete approach to plant maintenance, helping to ensure optimum performance and reduce any downtime to an absolute minimum. SCM offers a ‘joined-up’ approach by monitoring the health of an entire plant. While individual sensors provide a ‘traffic light’ warning indication at the machine, plain text information from multiple sensors is transferred via ethernet to the smart sensor controller – for in-depth monitoring and more detailed analysis.

In this way, the system is able to provide detailed diagnostics and offer suggestions for where additional measurements should be taken. Maintenance staff are provided with much more precise error-identification and along with recommended remedial actions for flagged issues, in the form of text messages. This information can then be networked to higher-level systems for ongoing trend analysis across the entire plant.



By utilizing FA and IT technologies, we will reduce the total cost of development, production, and maintenance, continue to support customer improvement activities, and propose solutions that aim for monozukuri that is one step ahead.



<https://www.mitsubishielectric.com/fa>

Automating business to transform society

Industrial pioneers like Henry Ford, who combined technology and human skills to create the world's first mass-production lines could, in a fundamental sense, be described as a pioneer of automation. And yet his most famous quote, that "customers can have their car in any color they like, as long as it's black", is an ample illustration of just how much the world of automation has changed since then. Ford's innovation may have reduced car assembly times from twelve hours to 1 hour 30 minutes, but it also brought limitations which did not exist before. Today's automation does not add limitations, it removes them, offering consumers wider choices along with increasingly shorter lead times.

History shows that applying innovations in new contexts often opens up new markets and multiple fresh opportunities. The processes of automation and systemization that have allowed us to utilize more information, in an appropriate context, in a faster way. Internet pioneer Sir Tim Berners-Lee, whose vision was about the sharing of scientific information between his colleagues, would probably never have imagined the fundamental societal changes his work has brought. We now have ever greater access to information, a wider choice of suppliers and the ability to monitor activities remotely – including the ability to interact with manufacturing processes in a more direct way than ever before.

Perhaps the greatest lesson we can learn about changing the world lies in recognising the power of the individual person. The great individual 'movers and shakers' from history, people like Mandela, King and Pankhurst, have within them the power of Kaizen – the unshakeable commitment to taking those small incremental steps which ended up changing the world. Together we can automate the world, creating change for the betterment of all humanity – and a brighter, more sustainable future full of promise and hope. ■

“Almost 10 million yen savings over five years...”



**Real time visualization
of plant utilities**



“I was confident about the ROI since we had already saved more than we spent for our initial investment.”

Hideyuki Moriya, General Manager,
Production Department,
Famiel Confectionery.

Famiel Confectionery Co., Ltd. in Japan, has implemented energy management and demand monitoring at its head factory by introducing Mitsubishi Electric's energy saving data collection server "EcoWebServerIII". In addition to allowing Famiel to lower its contracted power supply level, the expansion of energy saving activities through real time visualization of energy and water consumption has led to a significant reduction of costs – more than 10 million yen over five years.

Automating the World
For a Sustainable Future.

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Making a difference to people's lives:

the real-world power of automation

'Automating the world' is about improving people's lives, in all corners of the globe.

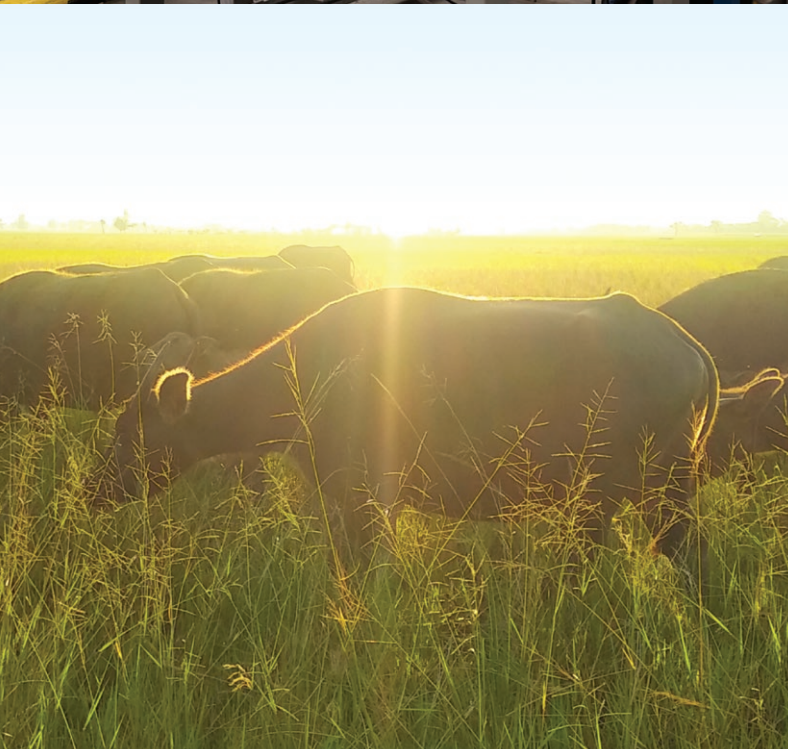


Mitsubishi Electric's Guided Operator Solutions is based on the principles of Poka Yoke, a Japanese term that means 'mistake prevention'. Poka Yoke is a method of eliminating mistakes in a manufacturing at source before they can occur and can comprise of various component options.

Automating the world – success stories

In today's industrial landscape, productivity and sustainability can never again be seen as mutually exclusive concepts. Automation is pointing us to a future of continuous improvement where fulfilling, high-efficiency workplaces are the norm. 'Automating the world' is about the story of people and technology in harmony. It's about innovation and imagination delivering new promise and new hope through the creation of long-term solutions to issues which threaten our very survival as a species.

The inspiring examples that follow, show how creative partnerships can harness innovative technologies to tackle issues like waste management, labor market mobility, diversity issues and carbon emissions from the built environment. These are the positive, incremental changes that are helping to build communities, enhancing lives and in the process, helping to create a greener, more sustainable future for every person on the planet.



From buffalo mozzarella to green energy



Roana Zootechnical farm is in the countryside of Latina, Italy, and is home to approximately 1100 water buffalos.
www.youtube.com/watch?v=PS7IWWpIEIY

Roana Zootechnical farm in the countryside of Latina, Italy, is home to approximately 1100 water buffaloes. Every day, these animals provide over 3 tonnes of milk to produce a celebrated buffalo mozzarella cheese. The herd also produces around 60 m3 per day of usable livestock manure.

But rather than just using this as fertilizer, the farm sought to maximize its usefulness and make a positive environmental impact by turning it into bio-energy, generating more revenue for the business in the process.

Local renewable energy specialist ProgestAmbiente was chosen to build the green power plant.

To optimize its automation infrastructure, the farm required an advanced control network to monitor the anaerobic digestion process and maximize productivity. CC-Link I&E Field provided the right solution, connecting a series of Mitsubishi Electric factory automation components with a flexible open industrial Ethernet solution delivering Gigabit bandwidth.

Methane gas delivers energy - and profits

Now built, the plant collects manure from the stables into a pretreatment tank, which homogenizes and equalizes the material. Various bacterial strains digest biomass and generate a methane-rich biogas which is directed to a purifying treatment plant and then to a gas-powered generator, which produces enough electricity to push power back to the grid.

Roana now can produce 2,400 kWh of electric energy every day, generating an extra revenue of EUR 15,000 per month for Roana.

Carmen Lemma of Roana said: "We appreciate the fact that the plant can manage itself autonomously. The system is intuitive and easy to use, helping all of our operators to effectively use the system."

Discussing the partnership at the heart of the project, Michele Di Stefano, Project Manager at ProgestAmbiente said: "we rely on Mitsubishi Electric's automation products and the CC-Link IE family of open industrial Ethernet. The performance offered by these solutions is unmatched on the market."

Poka Yoke provides ideal outcome for disabled workplace



Despite the rapid advance of factory automation, there will always be situations where manual workstations are essential. One of these is Martinshof Werkstatt Bremen, Germany's oldest and largest sheltered workshop. Employing over 2000 people, the workshop has been a fully-fledged supplier to the automobile industry for more than 30 years.

The challenge has been to develop solution which would provide fulfilling working life for people with a wide range of physical and mental disabilities and maximize productivity too.

Error-free solution for adapted working

Werkstatt Bremen's long-term supplier Handke Industrie-Technik worked with Mitsubishi Electric's 'Guided Operator Solutions' to develop an error-free solution based around the Japanese Poka Yoke principle.

Poka Yoke is a Lean Manufacturing concept which refers to the systematic elimination of human error at the earliest stage of any process.

Mitsubishi Electric and Handke developed their manual workstation solution in the form of a modular system with a range of components and interfaces for operator guidance. Mechanisms to ensure the correct picking of parts include light barriers, pick-to-light push buttons, barcode scanners, and proprietary pick-to-door devices with stroke switches.

"Practically any employee can now do the job."

Commenting on the development process, Nils Knepper, Senior Product Manager Modular PLC/Software at Mitsubishi Electric Germany said:

"The main challenge of this project involved the integration of existing technology into the new error-free workstations. Thanks to the interfacing features of our Poka Yoke controller, this was not a problem."

Discussing the benefits of the new solution, Miriam Berger Martinshof Werkstatt's Production Planner said: "Because many of our employees cannot read very well, we can make use of smileys and other symbols. And in addition to process reliability, practically any employee can now do the job."



The Poka Yoke success story on YouTube

Automation to achieve Zero Energy Buildings



It is widely recognised that buildings are responsible for 40% of global energy consumption. This is why developing 'Zero Energy Buildings' (ZEB) is essential for reducing energy consumption and carbon emissions around the world, a fact recognized by Mitsubishi Electric in its response to the UN's Sustainable Development Goals.

As part of that response, Mitsubishi Electric will utilize its Sustainability and Energy (SUSTIE) facility to engage in a range of strategies aimed at meeting the demand for ZEB-compliant technologies.

ZEBs are buildings that offer comfortable indoor environments while maintaining annual primary energy consumption at or near zero.

Five-point strategy to safeguard the future and improve lives


The concept for SUSTIE was developed in collaboration with Professor Shinichi Tanabe of Faculty of Science and Engineering at Waseda University in Tokyo. The facility itself was designed, constructed and supervised by Mitsubishi Jisho Sekkei.

Technological development will also be advanced in accordance with Mitsubishi Electric's ZEB+ concept for enhancing building functionality, including efficiency improvements to the working environment in terms of productivity and comfort.

1. Significantly reduce power consumption by installing Mitsubishi Electric's unique high-efficiency equipment.
2. Further improve ZEB performance using natural energy from sunlight and wind.
3. Utilize building simulation technology to predict energy consumption and comfort levels.
4. Contribute to workers' health by creating an office that offers both energy savings and comfort.

SUSTIE has received the highest 5-star rating and net Zero Energy Building (ZEB) certification from the Building-Housing Energy-Efficiency Labelling System (BELS). It has also received the highest S rank from the CASBEE Wellness Office, a certification system for health and comfort. Building upon this success SUSTIE has also achieved Platinum WELL certification - the highest level possible, certifying its status as a building that does the absolute maximum to enhance the health and comfort of its occupants.

“It sped our processes up tremendously...”



Improved visualization
and reporting with
industrial PC solutions



“With the new system, we can look at the report and we can go right to the problem areas. It allows us to make improvements right away.”

Tony Ingram, Senior Staff Engineer,
FCC (Adams), LLC.

FCC (Adams) is a clutch manufacturer providing high-quality automotive parts. With their focus on excellence, they wanted a tracking system that responded quickly to find any manufacturing faults. Mitsubishi Electric was able to take their ideas and reporting system to customize a new data collection system.

Automating the World

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Visualizing the future

Advanced Technology R&D Center - Changing things through Automation

As its name suggests, the Advanced Technology R&D Center conducts comprehensive technological research, and many of the new technologies and products announced by Mitsubishi Electric originate from this institute.

In order to enrich the world through automation, our research is not limited to the development of factory automation technology; just as the goals of the SDGs are intricately related, so are the challenges facing the modern manufacturing industry and society. In order to solve these issues, we are concurrently conducting research in a wide range of fields.



The Advanced Technology R&D Center is committed to continuous technological innovation to bring a more vibrant and sustainable world to all.

At Mitsubishi Electric, where all of our activities depend on advanced technology, The Advanced Technology R&D Center facilitates Mitsubishi Electric's dynamic growth and supports the business through a variety of R&D-driven initiatives in new business and new product development.

Mitsubishi Electric's groundbreaking developments in automated driving and haptics technologies are aimed at improving the lives of many people around the world.

Automatic driving technology

Fully self-driving cars: where is the technology now?

The world has been talking about self-driving cars for quite a while now. Step by step, fully autonomous driving has been moving closer to becoming a reality; trials on public roads are already underway and the benefits to society will be significant. In conjunction with electrification and ridesharing, vehicle automation will help us create a cleaner, greener world by cutting road accidents and fatalities, reducing traffic congestion, cutting transportation costs and dramatically curbing global CO₂ emissions.



Autonomous driving technology is more advanced than we can imagine.

The notion of relinquishing control of their cars can cause safety concerns for many, but the truth is that autonomous driving technology promises to deliver vastly improved road safety. As our development team at the Advanced Technology R&D Center points out in this article, the first and primary concern has always been to do with keeping people safe. These concerns have now been largely addressed and as we find out, their work is now taking other factors into account, including comfort and efficiency.

We might not be there yet, but it is exciting to know that fully autonomous driving is not so very far away. It is envisaged that from 2025-2030 for instance, self-driving buses will be on the road. Explaining where the technology is at the moment.

“

Both route generation and vehicle control technologies are already at a level that can be applied to simple environments such as highways. On the other hand, there is room for improvement in the sensing function that recognizes the surroundings, and establishing the mass data processing technology required for practical use.

Masaya Sakai,
Senior Manager, Autonomous Mobility Control section

”



Five levels of autonomy

So how do we define 'autonomous driving'? The Society of Automotive Engineers defines six levels of autonomy, drawing a distinction between assisted driving technology and automation driving technology. Assisted driving technology – at levels 1 and 2 – assists in driving but still requires humans to operate the vehicle. Fully autonomous cars may be the ultimate prize, but features such as automatic emergency braking, adaptive cruise control and lane departure sensors are a reminder that many of the cars we drive right now are autonomous to some degree. Automation driving technology – at levels 3-5 – refers to AI systems that enable vehicles to intervene and make driving decisions independent of the humans they are carrying.

A level 3 car commands all safety-critical functions and in certain conditions it can take over the driving, alerting drivers to take back control. Level 4 is a significant step up to complete autonomy. Level 5 is used to describe cars that are completely autonomous and can self-drive at any time, in any scenario. This is full automation. Without humans to drive them these cars would, in theory, have no need for steering wheels or pedals.

At level 4 and level 5, sensors create a detailed and dynamic map of the vehicle's surroundings. Sensors recognize white lines, surrounding vehicles, pedestrians, obstacles and so on, to determine the appropriate driving path. The Mitsubishi Electric ATR team is developing technologies which enable in-vehicle systems to take into account all those other human factors which contribute to safe driving.

In fully autonomous cars, multiple sensors such as millimeter-wave radar, cameras, and LiDAR are used to recognize the driving environment such as road boundaries, signs, and traffic lights, as well as traffic participants such as surrounding vehicles and pedestrians. Light detection sensors can bounce light from the vehicle's surroundings to determine distances, road boundaries and markings. In-vehicle software systems process all of this data and instruct the car's actuators for steering, braking and acceleration.



Taking automation ever closer to human driving: We talk to the Advanced Technology R&D Center's Robotics team

Working alongside Masaya Sakai in the Advanced Technology R&D Center's Robotics team are researchers Shota Kameoka and Kenta Tominaga Ph.D. We asked the team to tell us more about their work in taking automated vehicle operation to the next stage.

As drivers, we recognize that being safe in the car is about much more than just avoiding obstacles. And as Sakai points out, when a person is driving a car, they are subconsciously taking other things into account; such things as information about the vehicle and its surroundings, the weather, the speed of the vehicle, steering angle and so on. This is why, he says, the in-vehicle technology that they are developing must replicate all of these factors:

"To bring automated driving closer to human driving, the ATR have developed a new path generation technology. Path generation using a particle filter has the advantage of being able to take into account road surface conditions and vehicle motion characteristics. When a person drives a car, it is not only the presence of obstacles that determines the route to be taken."

Path generation refers to all the elements that help determine which route a vehicle will take. It consists of two methods: particle filter route generation and RRT (rapidly-exploring random tree) route exploration.

Particle filters allow the system to take into account such factors as road surface conditions and vehicle motion characteristics. This technology uses probability distribution to predict data changes by scattering particles around an object in virtual space. As the object moves, the distribution of these particles changes, and these changes are then analyzed to determine the optimum path.

"With the improved performance of in-vehicle microcomputers, it is now possible to estimate the state of a vehicle using a particle filter," adds Kameoka. "A particle filter is used to estimate the ideal position change for the car to approach the target state, such as the center of the lane, and create a route."



Masaya Sakai, Ph.D
Senior Manager
Autonomous Mobility Control



Shota Kameoka
Researcher
Autonomous Mobility Control



Kenta Tominaga, Ph.D
Researcher
Autonomous Mobility Control

RRT technology selects the optimal route by taking driving routes created by particle filter and expands them into a tree. Because RRT recalculates every 500 milliseconds to determine the optimal path through the tree, it is able to assure passenger comfort with smooth handling which avoids abrupt steering or sudden deceleration.

New technologies through problem-solving

Breakthrough technology is of the result of work to overcome particular issues. One of the problems that they had to overcome is that vehicles do not always perfectly follow the target path, due to the coupled longitudinal and lateral motion of the vehicle and the strong nonlinearity of tire grip.

Breakthrough technology is of the result of work to overcome particular issues. One recent problem that Sakai, Kameoka and Tominaga have had to overcome is to do with the time lag between a car's speed and the steering angle, which results in the vehicle not following the perfect target path.

They are working on developing efficient algorithms that can perform advanced arithmetic processing on automotive microcontrollers and optimizing control signals by calculating them backwards.

"Conventionally," says Tominaga, "control signals were determined by looking only at points on the target route. We aim to avoid it."

Creating a better world for all

Most studies agree that up to 90% of all road accidents are caused by human error. If most human error on roads can be eliminated, it stands to reason that the widespread adoption of autonomous driving will massively lower the numbers of traffic deaths around the world. Fewer accidents will result in less congestion and therefore a drop in emissions, along with lower insurance costs.

The work of the Advanced Technology R&D Center in making autonomous driving a reality is an inspiring testament to the power of our slogan automating the world.

Visual haptics

Using haptics to expand the scope of human activity

Haptic technologies to operate and control equipment remotely have been used extensively in several industrial fields, including the automotive and FA industries, but these systems have generally lacked the sophistication and operability to be more widely adopted.

With this in mind, Mitsubishi Electric has developed an Intuitive Remote Control Service Platform, based around characteristics of human cognition. This technology is expected to be of huge benefit in helping address widespread issues associated with ageing population, labor market mobility and labor shortages.

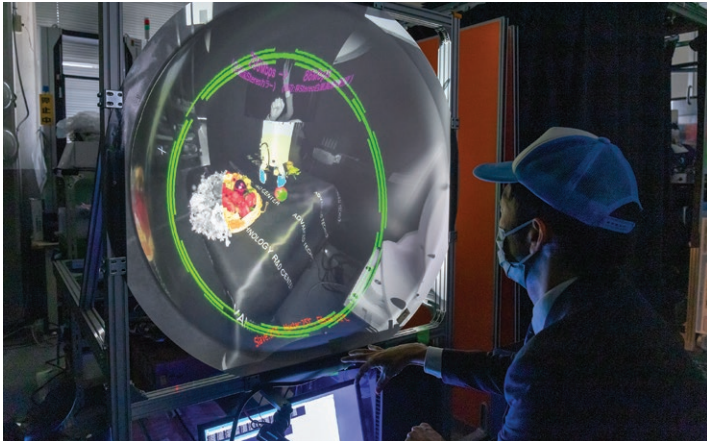
The Platform comprises three discrete technologies: Visual Haptics, Human Eye Display and Gradual Automation.

Visual Haptics – colors represent force

Up to this point, conveying the sensation of a robot hand grasping an object, has involved equipping the operator's hand with a glove or other device which contains motors and sensors to convey that sensation from the robot hand to the operator's hand. Such devices, although effective, are often unwieldy and uncomfortable to use. Visual haptics offers a new and simpler way to convey this feedback, by using color changes on a screen rather than mechanical force. A system of Augmented Reality (AR) overlays colors onto the hand, so that when a person operates it from a remote location, a change of color is recognized as a change in force. This provides the interaction (cross-modality) needed between the human sense of sight and the haptics.



A remote controlled robot that picks fruit with the same moderate force as a person and without crushing them. The day is near when this will become a reality.



In order to reduce data traffic and to achieve simple, light operability, the Human Eye Display was developed with a focus on human cognitive characteristics.

Human Eye Display – mimicking how we see

In the world of remote control, it is important that images and control signals be exchanged in real time. But when people are operating from a remote location, delays are simply unavoidable – and these delays impair the user's experience. This is why the Human Eye Display has been designed, to give the communication a 'definition'. It works by only transmitting certain parts of the pictures in color and high resolution, sending the other parts in monochrome and low resolution. This reduces the amount of data needing to be transmitted, minimizing delays and bringing improved functionality and effectiveness. This ability to 'focus', is a characteristic of human vision that has high vision in the central region, low vision in the peripheral region, where in reality images are unfocused.

Revolutionary Automation

The third of the three technologies that comprise the Remote Control Service Platform is gradual automation. This is when we gradually change to automation, step-by-step, via tasks that are easy to automate. A key benefit of gradual automation lies in the fact that it allows people to only concentrate on the tasks which require their attention. So it reduces the burden on people and it also makes it possible for one person to remotely control multiple robots.

“...labor shortages are becoming apparent all over the world so with the use of remote control technology, it is possible to work in the area where you were born and want to live.

Masaki Haruna, Ph.D,
Mechanical Dynamics Sect.



The compact and highly efficient AI Maisart automates repetitive unconscious tasks and frees them from simple tasks

Inspired by Sustainable Development work

The impetus for developing the Remote Control Service Platform came via Mitsubishi Electric's Sustainable Development Goals project in Indonesia. As Dr Masaki Haruna, of the R&D Center's Mechatronics Engineering Department recalls:

“Through a project to popularize refrigerators, I strengthened my desire to support developing countries, but realized it is unrealistic to expect people to leave the place they are used to living in. However, labor shortages are becoming apparent all over the world so with the use of remote control technology, it is possible to work in the area where you were born and want to live.”

The project demonstrates that at a site where there is a manpower shortage, a system can be created in which a robot operator from a remote location can perform part of the work – and be compensated for that work. Another advantage of the platform is that it does not force people in these regions to have to wear traditional feedback devices.

Online shopping possibilities by 2025

The Remote Control Service Platform centered on visual haptics was originally conceived to be used in scenarios where dangerous materials such as explosives were handled, but Mitsubishi Electric's policy is to always aim for application in the widest possible range of fields.

In this way, the haptics technology will make it possible to shop online and still replicate much of the experience of being in a real, live store. The team is also exploring the possibility of using robots to serve customers, in place of people.



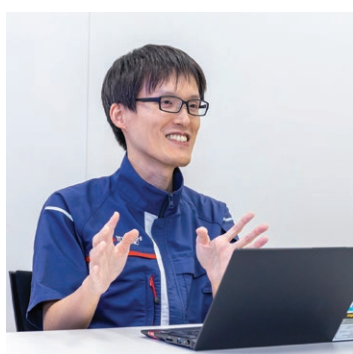
Soon it may be possible for shoppers to hold and examine and choose the produce they like.



With the aid of autonomous driving, cargo could be handled and delivered using AR controlled robotics.



Masaki Haruna, Ph.D
New Business Strategy and AVATAR
Technology / Manager
Sect., Mechatronics Dept.



Munetaka Kashiwa, Ph.D
Senior Manager, Mechanical Dynamics
Sect. Mechatronics Dept.

Possibilities for the logistics industry

It is also anticipated that the Remote Control Service Platform will be used in the logistics industry. In tandem with autonomous driving technology, it will be possible to remotely control the transportation truck and also the cargo handling.

"Cargo handling is labor-intensive work, but as long as it is a robot that actually carries the cargo, it doesn't matter if the robot is operated by a man or a woman, does it?" (Dr Masaki Haruna, Mitsubishi Electric R&D Center).

Agricultural and manufacturing applications

There are also possibilities for the application of the haptics technology in agriculture where it could be used for harvesting fruit. Now farmers will no longer have to do all of the time-consuming harvesting. Remote controlled robots can do some of it for them. At the same time the farmer's labor shortage problem is alleviated, there could be an opportunity for a short-term part-time job for a remote operator.

A similar system could be employed in the manufacturing industry, where remote workers could carry out transport and product inspection work remotely. Once again, the manufacturing industry could solve its labor shortage problems and remote operators could obtain new sources of income.

Opening up a world of remote control possibilities

While there are of course, some issues still to be resolved (including legal ones) Mitsubishi Electric's Remote Control Service Platform presents the world with an array of possibilities to address a range of social and economic issues and solve labor-related issues for many of the world's industries. ■

¹ CES2023: https://ces.mitsubishielectric.com/wp-content/uploads/2023/01/Visual-Haptics-Technology-video_high-resolution_1.mp4

² M. Haruna, M. Ogino, and T. Koike-Akino, "Proposal and Evaluation of Visual Haptics for Manipulation of Remote Machine System," *Front. Robot. AI*, vol. 7, Oct. 2020, doi: 10.3389/frobt.2020.529040.

³ M. Haruna, N. Kawaguchi, M. Ogino, and T. Koike-Akino, "Comparison of Three Feedback Modalities for Haptics Sensation in Remote Machine Manipulation," *IEEE Robot. Autom. Lett.*, 2021, doi: 10.1109/LRA.2021.3070301.

⁴ Small world project (PDF): https://www.mitsubishielectric.co.jp/corporate/sustainability-square/report/images/2017/SWP_E.pdf

⁵ Small world project (video): <https://www.mitsubishielectric.co.jp/corporate/sustainability-square/report/re2017.html?id=video01>



Mitsubishi Electric Servo System

AI MELSERVO J5 Series

Servo system for predictive maintenance and machine diagnosis

Labor shortages and the pressing need to achieve carbon-neutral targets are creating a demand for advanced work and digital manufacturing that can address both of these challenges.

The AI MELSERVO J5 Series has been developed with these issues firmly in mind. Boasting industry-leading servo performance, the J5 series represents 'automation evolution' in its truest sense. Equipped with the AI technology to go beyond human limitations, this is the servo system for the high-speed, high-precision production required to maximize the performance of your equipment and your systems. Its advanced functionality can be best described in these five words: innovation, connectivity, operability, maintainability and inheritance.

With regard to the maintainability dimension, the machine diagnosis function is able to detect age-related deterioration of equipment through the frictions and vibrations of such mechanical drive components as ball screws, belts, and gears. This function automatically generates a failure warning limit, detecting errors and conveying a warning upon signs of failure. The results of the failure, transmitted via CC-Link IE TSN to the motion module and IT system, can then be used for maintenance and overall machine diagnostics.

AI MELSERVO J5 Series: The next evolution in Mitsubishi Electric Servo technology. Industry-leading servo performance, single cable motor design, battery-less encoder, expanded predictive maintenance capabilities 26-bit encoder resolution.



Scan or click here to learn more.

3D Simulator

MELSOFT Gemini

Visualizing every shop floor to significantly reduce design and startup man-hours

Digital transformation has created new demands for faster processes, from product planning right through to commercialization. Which means it is more important than ever to eliminate time-consuming problems at line or equipment launch.

Mitsubishi Electric has developed its 3D Simulator solution in response to these issues. The Simulator is capable of verifying line equipment in a digital space, meaning pre-verification can take place in a virtual factory or equipment line.

In addition to equipment verification, layout verification - including movement of people and things - is also realized in 3D. Verification which simulates an actual production line improves productivity and significantly reduces maintenance man-hours.



Data Science Tool

MELSOFT MaiLab

AI data analysis and diagnosis

Mitsubishi Electric's Data Science Tool MELSOFT MaiLab has been developed to improve manufacturing processes by replacing 'human experience and intuition' with digital technology and allowing it to be easily incorporated into control systems.

This is intuitive UI and AI software which enables data analysis, the creation of learning models and estimation of abnormal factors within individual departments. It means that even personnel with no specialized knowledge or experience will be able to perform analysis and diagnosis tasks as well as controlling parameter settings. ■



Scan or click here to learn more.



Passion Road

When necessity became the mother of invention: How government directives drove innovation in Mitsubishi Electric's Nakatsugawa Works

Mitsubishi Electric's Nakatsugawa Works is known within the company as the Nakatsugawa of Wind for its development of wind-related products such as ventilators, blowers, hand dryers, jet towels and related products – for commercial and residential applications. In the spring of 2020, new Covid guidelines presented the team with several major innovation challenges.

In April 2020, a state of emergency was declared in Tokyo and other prefectures, forcing people throughout Japan to live in a way they had never experienced before.

To help prevent new coronavirus infections, Japan's Ministry of Health, Labor and Welfare issued guidelines for commercial organisations, including a ventilation requirement for commercial organisations of 30 cubic meters per person per hour.

Up to this point, there had been no necessity for in-factory ventilation fans to be switched on while machines were not running. But the new guidelines stipulated that as long as people were present, fans must be on, even when machines were not running.



“

This was problematic, recalls Toshiya Ohno, Development Team Leader, because “external inverter products are designed for situations where multiple units are controlled; they are not suitable for situations where individual adjustments are required on site.”

As a result, the team considered the option of changing to DC brushless motors with built-in inverters, as used in residential applications, in place of the conventional industrial motors that had been used to this point. Although there is a world of difference between these operating environments, adopting these DC motors would enable speed adjustments to be made on site.

Although factories were not specifically included, when we visited our customers' sites, we noticed that many of them also wanted to meet the MHLW's guidelines.”

”

Yasuyoshi Hamamura, Market Development Blower Group,
Equipment Sales Department 1, Equipment Division, FA System
Business Headquarters

A quest for lightness with strength

It became clear to the development team that the increased centrifugal force from higher rotation speeds that were demanded could well result in blade breakage. The solution appeared to be to develop blades made from a lighter material than the customary steel.

Toshikatsu Arai, who is involved in the development of ventilation fan elements at the Nakatsugawa Works, including research into new materials, recalls the moment he was approached about this project. He began to see this development project as an opportunity to reverse occasionally negative perceptions of his company:

“Resin is significantly lighter than steel, and unlike steel, which must be bent into shape, resin can be freely formed, creating value that has never been seen before and allowing us to turn around our reputation as a ‘money loser.’

Arai and his team tested a wide variety of materials for bending strength, flame resistance and heat resistance. At the end of their tests they concluded that polyphenylene sulfide (PPS) – a type of ‘super engineering plastic’, presented itself as the optimal material for the new blades.

Yet even at this point, some doubt still lingered within the team. “We were concerned,” says team member Yasuyoshi Hamamura, “that even if we attached conditions of use, they may not always be adhered to in the field.”

“The initial choice was resin, but it had to be strong enough to withstand both the degradation that comes from outdoor use and the large amount of waste heat generated by the factory. And all the while, costs must be kept low. The key to this new product was going to be about finding the best possible resin.” (Toshiya Onho)

“Even though repeated strength tests convinced the team that the PPS resin was strong enough, their assertions, based on theoretical calculation, could not provide enough information to completely dispel concerns. And with the motor still under development, the future remained uncertain.” (Tsutomu Takahashi).

Adoption of DC brushless motors

As with the new blade development, the choice of DC brushless motors with built-in inverters was also raising a major safety concern within the company. In this case, it was the risk of electronic components getting wet.

The team knew that no matter how securely industrial ventilation fans are installed in walls or ceilings, strong winds can still allow ingress of rain, resulting in equipment malfunctions and ultimately, possible electric shock.

The option of completely coating the circuit boards would have made them too expensive to manufacture, so the answer the team arrived at was to drill drainage holes in the case covering the circuit board, thus ensuring that even if rain did get in, it would quickly drain out.

The design that Ohno developed would allow the circuit board to float inside the case, so if rain were to accumulate inside, no water could reach the board. Testing to a rate of 240 millimeters of rain per hour, far in excess of the Japanese record for one hour of rainfall, the team saw no water accumulating in the case but rather, draining through the holes.



Tsutomu Takahashi,
Nakatsugawa Works, Ventilation Blower
Manufacturing Department, Industrial
Equipment Engineering Section



Toshiya Ohno,
Nakatsugawa Works, Ventilation Blower
Manufacturing Department, Industrial
Equipment Engineering Section



Toshikatsu Arai,
Nakatsugawa Works, Ventilation Blower
Manufacturing Department, Industrial
Equipment Engineering Section



Yasuyoshi Hamamura,
Market Development Section, Blower
Group, Equipment Sales Dept.



Final obstacles overcome

With the motor settled, the team set about finalizing its blade design project. Realizing they could not justify production of an expensive blade mold without further verification, they experimented by machining thin ventilation blades from a solid block of aluminium and attaching them to a DC brushless motor. Their conclusion, based on the data gathered, was that PPS resin blades in conjunction with the DC brushless motor, would be the best solution for providing the required airflow. Another advantage was that the wind power could be set at four levels and operated as easily as a household fan.

There was one last major problem around the difficulty of molding PPS resin. In order to determine the exact molding conditions required, the development team embedded a temperature sensor in the molding die to monitor the resin molding temperature in real time, experimenting to establish the optimal molding conditions.

A successful prototype

This led the team to completion of a PPS resin blade prototype which would test the veracity of its strength calculations. The test facility did in fact verify that the required specifications for the new product could be achieved at 2,200 revolutions per minute - although in fact, the speed of the blades in the test facility was considerably higher than this. Additionally, it also found that with deployment of the prototype blades, the air vortex, the source of ventilation fan noise, had been considerably reduced.



This new product is mainly targeted at gymnasiums and evacuation shelters as a countermeasure against new coronavirus infection, but I wonder if there is any prospect for further brushing up the two technologies of PPS blades and DC brushless motors for use in a wide range of industries

Toshikatsu Arai,
Nakatsugawa Works, Ventilation Blower Manufacturing
Department, Industrial Equipment Engineering Section



There is no doubt that this project has succeeded in improving the Indoor Environmental Quality (IEQ) that Nakatsugawa has been pursuing and moving it to a new stage. ■

News from around the world

CHINA

New FA Center in South China provides first-hand experience of intelligent manufacturing technologies

Service center

The new facility, located in the same building as the Mitsubishi Electric Intelligent Manufacturing Technology Innovation Center (Shenzhen), is providing technical service and support in Chinese, English and Japanese for customers in the South China region. It is also hosting training courses to help customers learn necessary skills and knowledge in automation, all supported by live showroom demonstrations.

The multi-purpose facility features the very latest automation products, technologies and solutions. It incorporates space for open innovation, training and meetings to help customers enhance their technical and innovative capabilities.

The two new centers will strengthen Mitsubishi Electric's customer support capability within the region and help guide manufacturers on their journey towards greener and more intelligent manufacturing.



GLOBAL

Beyond the realm of Factory Automation: 'Automating the World'

New slogan

Automating the World is an expression of how its development technologies can enrich society and change the world. The slogan encapsulates the beneficial impact of its Factory Automation solutions in helping to solve pressing issues across a wide range of fields. The new slogan has an aspirational element, in that it indicates the kind of next-generation business we should be striving to become.

**Automating
the World**

INDIA

Investment boost for Mitsubishi Electric India

National initiative

Earlier this year Mitsubishi Electric Corporation announced that it will invest 26.7 billion yen (US\$ 222.5 million) in its subsidiary company Mitsubishi Electric India Pvt. Ltd. The plan is to establish a factory for the production of room air conditioners and compressors in India. Local production is targeted to start in October 2025 and is expected to help the company to meet fast-growing demand in the Indian market.

Initial capacity for the new plant is expected to total 300,000 room air-conditioner units and from the start of December 2025, 650,000 compressors.



USA

Mitsubishi Electric presents 5-challenge vision at CES 2023, Las Vegas

Event

Mitsubishi Electric held an exhibition around the theme of 'Smart Society' at the Consumer Electronics Show (CES) 2023 held at the Las Vegas Convention Center from January 5-8.

At this year's show, Mitsubishi Electric presented its future vision for the provision of advanced technologies and integrated solutions across five challenge areas: Carbon Neutral, Circular Economy, Safety/Security and Well-being. It was also able to outline how the practical implementation of this vision can be brought to bear in addressing a range of social challenges.

Labelled 'the most influential tech event in the world', this year's CES featured 3,200 exhibitors from 173 countries, territories and regions.

JAPAN

Huge visitor interest at Smart Factory Expo 23i

Event

There was a great deal of visitor interest in Mitsubishi Electric Booth at the Smart Factory Expo 23, held at Tokyo Big Sight from 25 to 27 January.

Regarded as Japan's leading exhibition for Smart Factory solutions, Smart Factory Expo is respected as one of the world's most prominent gatherings for exhibiting and demonstrating all the latest technologies and solutions for smart factories. Visitors to the booth were able to see all the latest in digital manufacturing solutions from Mitsubishi Electric. They also had the opportunity to see our Digital Twins solutions - a technology which uses real-time data simulation to simulate processes and visualize an object or system across its entire life cycle.



JIMTOF

Propelling metal manufacturing to a brighter future: Mitsubishi Electric at JIMTOF

Event

Visitors to Mitsubishi Electric's booth at JIMTOF 2022 were provided with a fascinating demonstration of additive manufacturing technology, seeing at first-hand how the new AZ600 3D printer creates high quality 3D structures – in this case a propeller – using a laser beam to melt welding wire. The AZ600 wire-laser metal 3D printer has been developed in response to the growing need for more efficiency in metalworking methods. Creating objects on demand enables manufacturers to redesign and re-imagine products in ways that have never been possible before.

JIMTOF 2022 was the 31st Japan International Machine Tool Fair. The next JIMTOF is due to take place at Tokyo Big Sight from Nov 5 to Nov 10 2024.



Would you like to be featured in the next edition of monozukuri – The Art of Manufacturing? **Get in touch and share your success story.**

Taste^{of} Japan

For non-native speakers, Japanese written communication may seem overly complex, but it is probably easier to learn than many other languages. It is important to understand that Japanese writing is a combination of two types of system: kanji (picture symbols) and kana (syllables). Kana is further comprised of two distinct scripts: Hiragana (for Japanese words) and Katakana (essentially non-Japanese words). Hiragana and Katakana are in fact different versions of the same set of sounds.



Hiragana

Hiragana is the first alphabet that Japanese children and students learn to read and write. Comprising 46 syllables, Hiragana is a basic Japanese phonetic alphabet and is used to represent every sound in the language, in conjunction with Kanji. If there is no Kanji for a particular word, it can be spelled out in Hiragana and writers can change or modify the meanings of Kanji with the addition of a Hiragana character.



Katakana

Katakana, also comprising 46 syllables, is most commonly used for words which have been borrowed from other languages like English. It is used for the names of animals, plants and minerals as well as things like company or brand names. Katakana is used for onomatopoeia and for emphasis, especially on public signs or advertising billboards. The literal meaning of Katakana is 'fragmentary kana', because the words are taken from pieces or fragments of Kanji.



Kanji

Kanji are symbols – or ideograms – used to represent entire words or phrases. Kanji were taken directly from the Chinese writing some time around the 5th century, at a time when Japan did not have its own writing. Kanji translates literally as ‘Chinese letter’. Although there are tens of thousands of kanji, only around 3,000 are generally used in everyday communication, in conjunction with Hiragana and Katakana.

Romaji

Literally meaning ‘Roman letters’, Romaji refers to the use of the Latin script to write the Japanese language. Although Romaji has been taught in primary school since 1945 and today, almost all Japanese people are able to read it, its main purpose is for communication with non-Japanese speakers, which is why it will regularly be seen on street signs, billboards, public noticeboards and in public spaces.

Did you know?

Mitsubishi Electric Group is a global leader of IP (intellectual property) capability and global IP activities.

Ranked **41** in  Forbes Digital Top **100**

Mitsubishi Electric has been recognised as being among the world's most influential corporations with a listing in the new Forbes Top 100 Digital companies list. While humbling, the ranking is also an accurate reflection of its role as a leading global digital manufacturer – and a reminder of the continuing impact of its breakthrough technology right around the world.

Top **5** globally  for **8** consecutive years

As an indication, the company ranked No. 5 in the world in terms of Patent Cooperation Treaty (PCT) applications by businesses (in 2021) announced by the World Intellectual Property Organization (WIPO). Mitsubishi Electric have been ranked in the top 5 worldwide for 8 years in a row.

 No. **1** in Japanese firms for **7** consecutive years

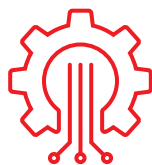
Mitsubishi Electric ranked No. 1 in Japan in terms of the number of patent registrations (in 2021) announced by the Japan Patent Office (JPO). Mitsubishi Electric have been ranked No. 1 among Japanese companies for 7 years in a row

2,673 PCT applicants: businesses in 2021

3,494 patent registrations in 2021

Focus on solutions using IoT & AI technology.

Mitsubishi Electric places intellectual property activities at the core of its global management, and plans to continue to strengthen its filing of patent applications in Japan and overseas. In recent years, they have been focusing on patent applications in the field of solutions using IoT (Internet of Things) and artificial intelligence (AI) technology.



Launch “Open Technology Bank” to create resolutions of diversifying social issues.

Mitsubishi Electric is a comprehensive electronics manufacturer engaged in a wide range of businesses from home appliances to space. They possess a wealth of technologies that contribute to solving problems in various fields. The “Open Technology Bank” will use the technological assets that Mitsubishi Electric has cultivated over the 100 years since its founding. They license to partner companies and support the development of new products and services. Through “multiplication” between partner companies and Mitsubishi Electric, they will contribute to the creation of new value and business, and the resolution of diversifying social issues.

For full details visit www.mitsubishielectric.com

Non-stop product evolution.



1933

**Industry first: Japan's
first fuseless 15-35A
circuit breaker**



In 2024, Mitsubishi Electric Factory Automation will celebrate 100 years of growth and innovation. It is now time to look forward to how we can support the digital transformation of our society. The evolution of all our products, symbolized by our development of Japan's first 15-35A fuseless breaker, demonstrates our commitment to pioneering new technologies and continuous development. Let's automate the world together and create a prosperous and sustainable future for all.

Automating the World

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