Scope
Kawasaki Heavy Industries Quarterly Newsletter
No. 124 Summer 2020

Kawasaki Heavy Industries, Ltd.
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Kawasaki
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Scope

Kawasaki Heavy Industries Quarterly Newsletter

Special Feature

Kawasaki's Floor Conversion System Using Air Technology Supports the Stages of Athletic Victories

カワる、
サキへ。
Changing forward

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Launching ceremony of the *Seven Islands Yui* Jetfoil at Kobe Works. For details, see *Techno Box* (p. 10).

Sports and Kawasaki I

Kawasaki's Floor Conversion Sy stem Using Air Technology Supports the Stages of Athletic Victories

Today, a wide range of people enjoy a variety of sports, and Kawasaki's "air technology" is facilitating this trend, supporting the operators of sports venues by broadening the uses of their facilities.

Where Japanese Martial Arts Flourish, the World's First Floor Conversion System Is Applied

Himeji City in Hyogo Prefecture is famous for Himeji Castle, a UNESCO-listed World Cultural Heritage site. It is also reputed to be a place where Japanese martial arts flourish, even more than other cities in the prefecture, which has produced many notable martial arts experts. Himeji-born artists include Mikinosuke Kawaishi, who was entrusted with the mission of popularizing judo in France by Kodokan Judo Founder, Jigoro Kano (Kobe-born), and who later became known as "the Father of French Judo," and Kyutaro Takahashi, the "Swordsman of the Meiji Era." And the venerated swordsman of the Edo period, Musashi Miyamoto, had a close association with the head of the Himeji Domain.

Given these connections, it is not surprising that the Hyogo Prefectural Government chose Himeji as the location for its WINK Budokan (Hyogo Prefectural Budokan [Martial Arts Hall]) in 2002.

Of the two dojos (practice halls) in this facility, Dojo No. 1 is equipped with the world's first automated floor conversion system which lays tatami (straw mats) for judo on top of the Japanese cypress floor used for kendo (Japanese swordsmanship).

Using this system, conversion from a kendo hall to a judo hall with four judo rings, which meets international competition standards, takes just 40 minutes. In the conversion process, a base of 32 tatami mats (each mat being about 1.8 x 0.9 m/5.9 x 3.0 ft), called a "tatami unit," is brought in on two automated guided vehicles (AGVs), with four tatami units completing one judo ring. Since the venue consists of four rings (16 tatami units), a total of 512 mats are used.

Converting kendo halls to judo halls by laying down tatami mats is a common practice, but it has always been labor-intensive, time-consuming, and costly. It is estimated that converting a regular martial arts hall into a judo hall that meets international competition standards, which require the hall to have a 50 cm high base, takes 10 workers two days, costing five to 10 million yen (about US$46,750—93,300).

For the operators of large public facilities, such as the WINK Budokan, having flexibility in the way the venue is used is key to achieving sustainable operations, and Kawasaki's floor conversion system provides a solution which contributes greatly to efficiency.

Director of the WINK Budokan, Nijo Kobayashi, comments, "While we were preparing for construction of the Budokan, Kawasaki provided a solution for our need for an automated system which achieves both effective operations and the size and level of facility required for international competitions. When the Budokan opened, people called the conversion system 'a magic carpet'."

The power of air is at play in this system. In 2001, Kawasaki delivered a "Hovering Stage" (a movable natural grass football pitch) to Sapporo Dome, which can be moved into and out of the stadium using pneumatic flotation technology for moving heavy objects. This system made the stadium operator's dream of hosting the 2002 FIFA World Cup come true. Another innovation contributing to this floor conversion system is an "air-raising method" that Kawasaki makes use of, in which the roof structures of liquefied natural gas (LNG) above-ground tanks are assembled at the bottom of the tanks and then raised using air.

Moreover, technology for the Flow Dynamics Conveyor (FDC), a long-lasting, high-speed, long-distance, air-supported belt conveyor, and other air-supported inventions were incorporated in the development of the Budokan's floor conversion system.

Nearly twenty years after its installation, a six-month project to renew the system began, and was completed in March 2020. Not only its aging parts but also its control system was replaced, as a result of which an improvement in the conversion speed was achieved.

Let's take a look at Kawasaki's technology which achieved the world's first floor conversion system using the power of air.

The WINK Budokan opened in 2002 on Mt. Tegara in Himeji City.

A Heavy Base Is Elevated and Moved Using AGVs

The floor conversion system is comprised of four components: 1. Tatami units (elevatable bases holding tatami mats), 2. AGVs that move and align the tatami units to create judo rings, 3. Storage lifters for tatami units and AGVs, and 4. Control equipment and panels for these components.

Each tatami unit is about 15 m (W) x 4 m (D) x 0.5 m (H) and weighs about 4.5 t. It is impressive that air can lift such a huge object.

Under the tatami unit, a balloon-like bag (called an "air mat") with myriads of holes on the bottom is installed, and when air is injected into the bag by a blower, the bag swells and elevates the unit about 40 mm. As the air then escapes through the holes, a layer of air beneath the bag is also created, reducing the friction between the tatami unit and the floor to one thousandth.

Osami Oogushi, who was involved in the development of the system and was in charge of the renewal project, says, "The floor for kendo, which is made of Japanese cypress, is so soft that if a carpenter's square is dropped, it can stick. We therefore designed the tatami units and the AGVs with utmost care so that they do not damage the cypress floor and that safety is ensured for kendo players who fight barefoot."

Each tatami unit is moved and aligned by a set of two AGVs, which slide under the unit and insert connecting pins into it so that the unit and the AGVs move together. At the same time, the AGVs provide power to the unit's blower. The elevated unit is then moved to the desired spot by the AGVs, which have tires that allow both forward/backward and left/right motion.

The layout of the units varies depending on how many judo rings are to be installed. The AGVs run on designated routes, guided by magnetic tracks and stop markers embedded in the floor which send commands to the AGVs, such as "stop in another 5 cm." This explains why they are officially called "magnetically guided automated vehicles."

Two AGVs Move in Perfect Coordination

Although the AGVs are guided magnetically, Oogushi says, "The most challenging aspect of using the AGVs in moving and aligning the tatami units is that they have to move in perfect coordination, which we call '*a-un* (harmonious) breathing'."

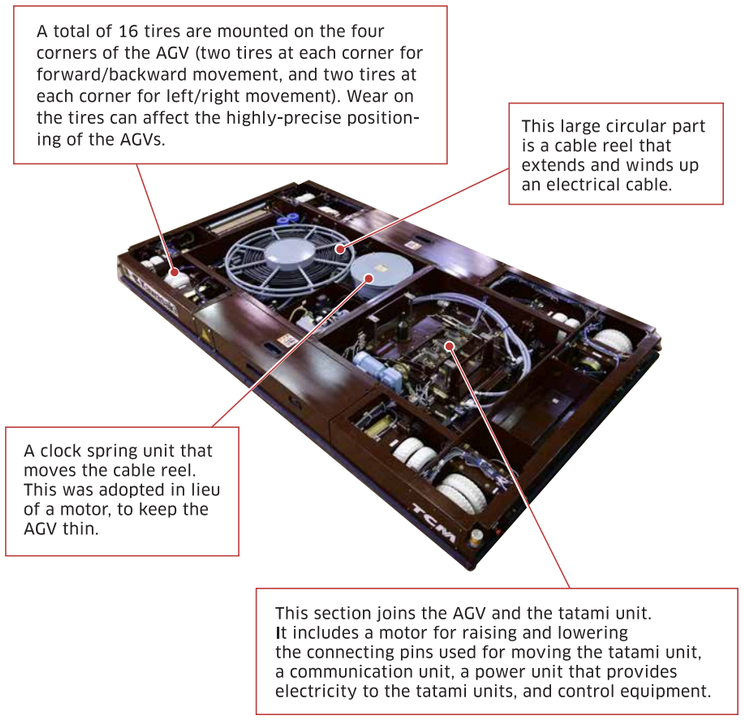
Osami Oogushi
Senior Staff Officer, Engineering Section 1
Materials Handling Department
Industrial Machinery Group
Plant Engineering Business Division
Energy System & Plant Engineering Company

Because they are transporting a 15 m long unit, even a slight discoordination can result in a major misalignment. To prevent this, Kawasaki developed a control technology that allows the AGVs to recognize each other's position using optical communication and move in parallel with each other — the "*a-un* breathing" technology.

Oogushi adds, "This technology realizes gapless alignment of the tatami mats, thanks to a level of precision which achieves a less than 5 mm difference between the AGVs every time they come to a stop, and a mechanism which ensures that the units are fastened tightly together."

Another feature contributing to efficient floor conversion is the storage lifter (lifting shelf) used to house the tatami units and AGVs. There are four storage lifters in the hall, with two each installed on opposite sides. This means that 16 units and eight AGVs can be hidden in four locations under the arena floor.

These storage lifters are located under the front row of seats and the area of the arena immediately in front of the seats. During operations, they are raised and lowered to unload/reload the tatami units and AGVs.



Weighing 40 t, a lifter is a 4-shelf structure that can hold 21 t worth of tatami units and AGVs. Because the height of each shelf of the lifter must align with the cypress floor when the tatami units and AGVs are being loaded/unloaded (around 60 t when the lifter is fully loaded), Kawasaki developed a positioning system to adjust the lifter to the perfect height.

The position and status of the tatami units, AGVs, lifters, and other equipment are controlled in real time via wireless communication, and by moving multiple pieces of equipment simultaneously, the system deploys and stores the tatami units in the shortest time possible.

Oogushi comments, "It was quite meaningful to develop this floor conversion system because it helped us establish technologies for creating heavy structures, elevating them using air, and controlling them to a millimeter level of precision. We can apply the system to transport other heavy objects from place to place, which is a significant labor-saving contribution."

Please also see feature stories on Kawasaki's Brand Site, "STORIES,"

which contains a video on how this fully-automated system lays tatami mats, and how the AGVs are returned to their storage positions.

https://global.kawasaki.com/en/stories/articles/vol96/

A completed judo hall. The conversion took only 40 minutes.

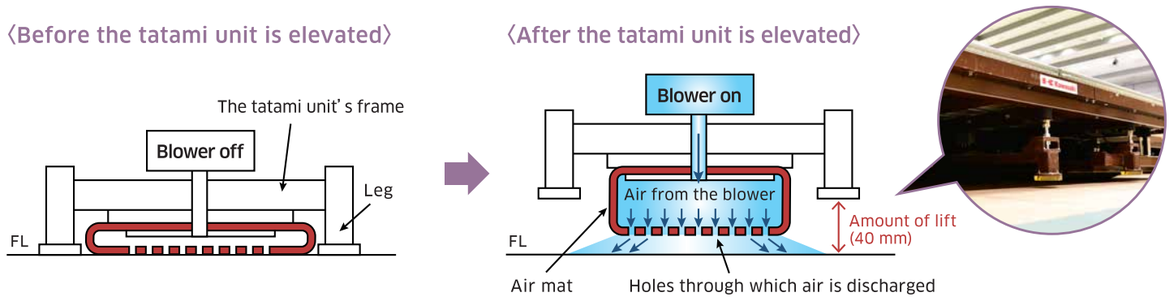
Dojo No. 1 has a total of 1,980 seats placed on four sides, with an omni-directional display system installed on the ceiling. The photo shows the cypress floor used for kendo.

The control panel for the floor conversion system. If someone enters the arena while the conversion is taking place, the system activates a safety mechanism to stop the operation automatically.

In this photo, a conversion has begun and two AGVs are working in perfect coordination to move a tatami unit weighing 4.5 t.

In the final stage of conversion, the tatami units are joined together without any gaps at the connecting sections found on every unit.

〈Before the tatami unit is elevated〉 〈After the tatami unit is elevated〉



How the tatami unit is elevated: The blower injects air into the balloon-like bag (air mat), and the bag swells and elevates the unit about 40 mm. The unit has myriads of holes at the bottom, and as the air escapes through these holes, a layer of air beneath the bag is also created, reducing the friction between the tatami unit and the floor to one thousandth.

products at Kawasaki, says, “Considering the scale of floor conversion systems, incorporating one requires Kawasaki to be involved in the project even before the designing process begins. Despite such a requirement, some public entities are already showing interest in the system.”

Emphasizing the value of the technology in enabling facility operators to effectively increase the availability of sports for local residents, Honda says, “The use of technologies which utilize the power of air, such as the floor conversion system, greatly enhances a facility’s operating rate and saves a significant amount of labor. It therefore contributes to the effective management of the facility.”

Kawasaki’s air technology is supporting the “stage of victory” for athletes in a city closely associated with Japanese martial arts. It is also meeting the desires of facility operators to enrich people’s lives through sports, and to support athletes in winning victories.

Yoshitaka Honda
Assistant Manager, Sales Section 2
Domestic Plant Sales Department
Marketing & Sales Division
Energy System & Plant Engineering Company

A System that Accommodates Diverse Sports Requirements

Kawasaki has been making efforts to develop new customers for this floor conversion system, as some of the 48 public martial arts halls in Japan opened more than 40 years ago and are failing to meet the wide range of local sports needs.

Yoshitaka Honda, from the sales department in charge of marketing air technology

A User’s Voice

Nijo Kobayashi Director, WINK Budokan

Flexible Conversion of Sports Halls Provides Facility Operators with Managerial Efficiency and Competitive Advantages

Opened in 2002, the WINK Budokan has been serving as a center for promoting and developing martial arts, the wellness and fitness of prefectural residents, and a life-long involvement in sports.

It is used mainly for 11 types of martial arts, including judo, karate, and *naginata* (glaive fighting). Our dojo halls are two of the largest in Japan that meet international competition standards. We enjoy a high operating rate, with various competitions held on weekends and mainly martial arts classes on weekdays.

For effective facility management, it is vital that martial arts halls be designed for multipurpose use. The floor conversion system in Dojo No.1, in particular, is a major contributor to the highly efficient running of the facility. Because conversion from the regular floor to the tatami-covered version and vice versa takes only 40 minutes, we have flexibility in planning our event schedule. Ever since I assumed the post of the Budokan’s eighth director in 2018, I have been committed to using this superior resource to our advantage in facility management.

During the renewal project, I observed Kawasaki engineers’ painstaking attention to their work, indicating a passion for their technology, while rigorous self-discipline is practiced in meeting the timeline. I feel that such an approach fits harmoniously with our desire to foster self-control through martial arts.

The WINK Budokan holds a variety of classes to promote martial arts, and its flexible scheduling is made possible by the floor conversion system.

Sports and Kawasaki II

Kawasaki’s Pneumatic Flotation Technology Supports Centers for Sports Promotion in Snowy Regions

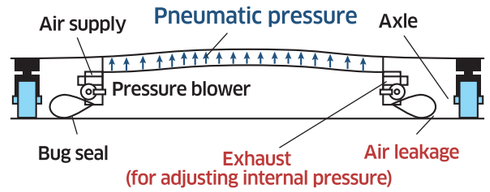
Raising an 8,300 t Football Field

The Sapporo Dome, which is located in snowy Hokkaido Prefecture, is an all-weather, multipurpose facility used for professional baseball games, J.League football matches, concerts, motor shows, etc. Launched in 2001, the stadium is equipped with a natural grass football field called the “Hovering Stage,” which can be moved using Kawasaki’s pneumatic flotation system.

The football field (“stage”), which normally resides in the outside arena (right photo), is transferred to the inside arena when such events as home matches of the professional football club, Hokkaido Consadole Sapporo, are held. In regard to the baseball field, the stands behind center field can be moved and the wall opened to bring the stage into the inside arena (photo above). The stage is then rotated 90 degrees so that the stands behind the backstop, where the number of spectator seats is the largest, become the grandstand.

Pneumatic pressure is at play when moving the stage. Pressurized air is pumped into the space directly below the stage and, at the same time, tubular bags (bug seals) which are installed under the four edges of the stage are inflated, trapping the air and creating upward pressure (see illustration below). This pneumatic pressure lifts the 8,300 t, 120 m x 85 m stage, reducing its dead weight to one-tenth.

How the Hovering Stage Is Levitated



Next, 34 wheels around the outer periphery of the stage are hydraulically extended down to the ground, and the stage is carried straight into the inside arena, guided by the same magnetic guidance system as that used in the WINK Budokan. The amount of air leaking from minute gaps between the bug seal and the ground varies according to the unevenness of the ground, but this exhaust air is controlled in order to maintain a consistent pneumatic pressure. It takes about two hours to move and rotate the Hovering Stage.

Tatsuo Tomono, Senior Staff Officer of the Plant Engineering Business Division, who developed the Hovering Stage, comments, “The Hovering Stage was used for both the 2002 FIFA World Cup at Sapporo Dome, which was co-hosted by Japan and South Korea, and the Rugby World Cup 2019. I’m sure it will be a stage for many more sports events. Hokkaido residents are very happy that Sapporo Dome is allowing them to enjoy indoor sports even during the winter, making the stadium a symbol of sports promotion in Hokkaido. I feel very proud that Kawasaki’s technologies are supporting the operation of the stadium.”

Tatsuo Tomono
Senior Staff Officer, Engineering Section 1, Materials Handling Department, Industrial Machinery Group, Plant Engineering Business Division, Energy System & Plant Engineering Company

Be a Provider of "Trustworthy Solutions for the Future"

Yasuhiko Hashimoto

In June 2020, Yasuhiko Hashimoto was appointed the new President and Chief Executive Officer (CEO) of Kawasaki Heavy Industries, Ltd. For this issue of SCOPE, the editorial team interviewed the new president to find out how the manufacturing sector is apt to change in the post-pandemic era and what Kawasaki Group's strategy for it will be.

Profile

Born in Kobe City in 1957. He graduated from the Faculty of Engineering, University of Tokyo, in 1981, and joined Kawasaki Heavy Industries, Ltd. the same year. He was assigned to robot development projects and launched the semiconductor robotic business at Kawasaki and established Medicaroid Corporation, a developer of robots for the medical sector. In 2018, he became Director and Managing Executive Officer and President of Kawasaki's Precision Machinery and Robot Company. In June 2020, he took on the post of President and CEO of Kawasaki Heavy Industries, Ltd.

In your opinion, what changes are required of the world's manufacturing sector today?

I think manufacturers are being tested for their ability to quickly accommodate changes and consistently continue upgrading the value they offer their customers. Today, manufacturers are required to improve the quality of the solutions provided by their products and to be capable of developing products more quickly in order to minimize the chance of missed opportunities being encountered by their customers.

For example, the volume of airplane production worldwide was expected to rise, but was instead severely hit by the COVID-19 pandemic, and that sector must now fundamentally change the way it manufactures products. Given this coronavirus calamity, we must think hard about what technologies we are able to offer and how they could be utilized.

The Kawasaki Group must therefore develop products with a shorter turnaround time, offer even more effective solutions, and practice effective sales communications using our long-standing *suriawase** (optimal integration) approach in order to keep generating new value. In short, we must commit ourselves to bringing our comprehensive technological capabilities to the world.

Is the Kawasaki Group sufficiently responding to these challenges?

Employees of the Kawasaki Group can be characterized as having integrity. Period. I am proud that they are so committed to offering products that satisfy our customers. The downside is that we sometimes do more than simply fulfill a customer's request, to the point where we prepare a full-course meal even though the customer is saying, "Instant noodles are fine — I'm hungry right now." Rather, we must sharpen our senses to discern how the world is changing and what needs are emerging, and increase our ability to respond speedily to those needs.

To achieve this, I consider it imperative to further promote digital transformation (DX), foster a culture where it becomes the norm to produce things in a shorter time frame, and be more selective in which of our businesses we focus on, in order to accelerate the speed of operations. All of our businesses must be reviewed and redefined from the perspective of customers' and market needs, rather than our own.

Cutting-edge technologies and solutions coupled with the suriawase approach enable Kawasaki to achieve sophisticated product manufacturing. (The photo shows Kawasaki robots producing cargo doors for the Boeing 777X at Kawasaki Motors Manufacturing Corp., U.S.A.)*

What measures has the pandemic compelled Kawasaki to take?

It has compelled us to accommodate changes rapidly as a company and at the same time demands mindset transformation on all our parts individually. This means that "KAWA-ru, SAKI-e Changing Forward" — the motto that former president Kanehana advocated — must accelerate at once. We must first change our personal mindset and then that of the people around us.

For example, the popularization of teleworking due to the pandemic made us keenly aware that there is value in not always being on the move. However, Kawasaki manufactures airplanes, rolling stock, and many other products that support the value obtained by going from one place to another.

In terms of our products which aren't "on the move," such as industrial plants and robots, it is important to provide more IoT-based solutions. In regard to our products whose value is intrinsically tied to movement, such as airplanes and rolling stock, valuable new features, such as a mechanism to prevent infections from spreading from one passenger to another, must be explored in addition to general safety and comfort. I'd like to work on building a mindset among employees that flexibly accommodates expeditious change.

May we ask why you wished to become a robot engineer?

"Astro Boy" and "Iron Man No. 28" were my childhood passion, and I was a boy who was always doodling structural designs of robots in the margins of my textbooks. In my university days, I had opportunities to serve as a volunteer for persons with muscular dystrophy, and I heard one mother saying, "Ever since my child was born, I haven't slept for more than two hours at a time because I needed to roll the child over every two hours." It was then that I determined to make a robot useful to the medical and nursing sectors.

The Kawasaki Group has long been manufacturing products that sustain society, and starting in spring of next year, we will begin building a hydrogen-energy-based society. I believe that technological innovation is born out of product developers' and providers' passion for wanting to contribute to society. I think, therefore, that offering to the world "Trustworthy Solutions for the Future" is what we should commit to as the Kawasaki Group.

* *Suriawase* (lit. fitting, reconciling): A product-making approach in which any problems arising during both development and manufacturing processes are resolved through optimal integration of different technologies at each stage, beginning with prototype-making, in order to achieve sophisticated features and quality in the end.

Techno Box 23

Passenger Hydrofoil with Fully-Submerged Foils: Kawasaki's JETFOIL

Commentary by

Shinsuke Kikuno (left)
Assistant Manager
High-Speed Ship Designing Section
Initial Design Department
Engineering Division
Ship & Offshore Structure Company

Takatoshi Taniguchi (right)
High-Speed Ship Designing Section
Initial Design Department
Engineering Division
Ship & Offshore Structure Company

Kawasaki Produces JETFOIL — Vital for Remote Islands — for the First Time in 25 Years

The JETFOIL, a type of passenger hydrofoil with fully-submerged foils, is considered essential for traveling to and from remote islands. Powered by gas turbine engines, waterjet propulsors (pumps) draw in and then discharge seawater, generating lift by means of a set of fully-submerged forward and aft foils, thereby raising the hull above the water's surface. Achieving a maximum speed of 45 knots (83 km/h), it cruises stably even in rough seas with wave heights as much as 3.5 m. It certainly deserves to be called a "flying ship."

A hydrofoil with fully-submerged foils was originally developed by The Boeing Company of the U.S. in an effort to apply aerospace technology to marine products. In 1974, a passenger-carrying hydrofoil was launched, which was named "JETFOIL," as it resembled a jet with sharp, leaf-like wings. In 1987, Kawasaki acquired the manufacturing and sales licenses from Boeing, and 15 units were manufactured in Japan between 1989 and 1995.

A quarter-century later, a new JETFOIL was produced and delivered at the end of June to Tokai Kisen Co., Ltd., a Japanese maritime transport company. This 241-passenger ship, which was christened *Seven Islands Yui* ("*yui*" means "to knot, to connect"), has replaced the 36-year-old *Seven Islands Niji* ("rainbow"). The JETFOIL connects Tokyo and Oshima Island in an hour and 45 minutes, a trip which takes six hours on large passenger ships, marking a new chapter in its history.

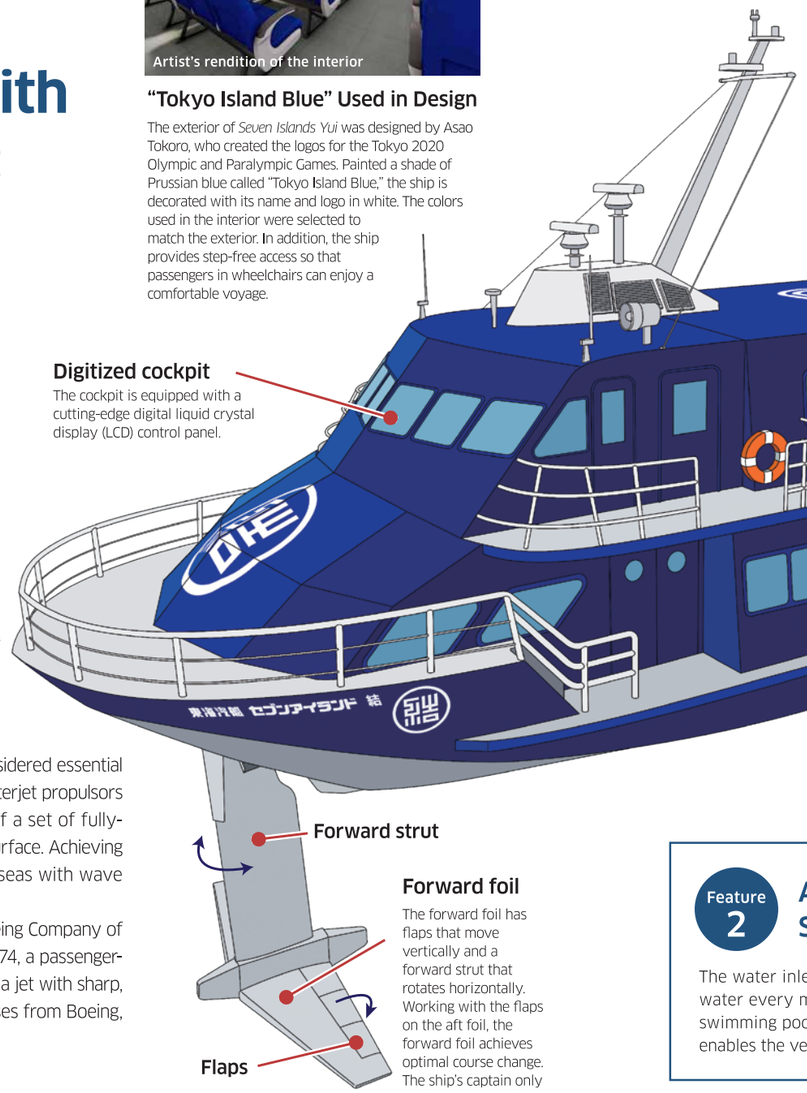
ACS Realizes a Voyage Free of Seasickness

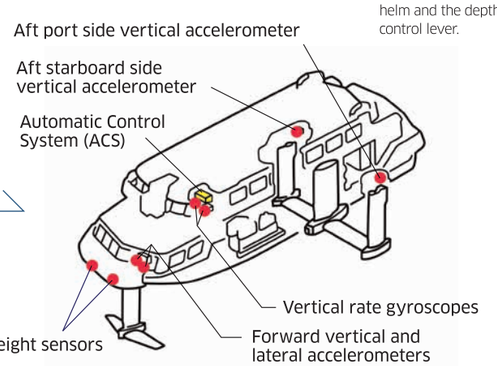
The stable sailing of the JETFOIL, with minimal pitching and rolling, is attributable to eight sensors that detect the ship's attitude and movements and the ACS (Automatic Control System), which constantly controls pitching, rolling, and other movements, providing passengers with comfortable, seasickness-free travel. When the ship needs to change course, the ACS moves the underwater flaps vertically (up or down) to tilt the ship in the direction of the turn, and at the same time rotates the strut of the forward foil in order to achieve a smooth turn. This action, just as in an airplane, counteracts the centrifugal force created during a turn and keeps passengers from experiencing lateral pressure even when the ship turns at top speed at its turning radius of 220 m.

Artist's rendition of the interior

"Tokyo Island Blue" Used in Design

The exterior of *Seven Islands Yui* was designed by Asao Tokoro, who created the logos for the Tokyo 2020 Olympic and Paralympic Games. Painted a shade of Prussian blue called "Tokyo Island Blue," the ship is decorated with its name and logo in white. The colors used in the interior were selected to match the exterior. In addition, the ship provides step-free access so that passengers in wheelchairs can enjoy a comfortable voyage.





Feature 1 — The Propulsion System — JETFOIL's "Heart"

JETFOIL's propulsion system is comprised of two gas turbines, installed on the port and starboard sides, reduction gearboxes, and waterjet propulsors. More specifically, it is equipped with Rolls-Royce-produced gas turbines with an output of 2,794 kW each, Kawasaki Powerjet 20 waterjet propulsors that achieve 2,060 rpm, and reduction gearboxes that transfer the turbines' rotational force to the propulsors. These elements work together to draw in seawater and then discharge it at high pressure from the rear of the vessel, creating the thrust needed for the ship to sail. In addition, according to Assistant Manager of the High-Speed Ship Designing Section, Shinsuke Kikuno, "The vessel incorporates a fail-safe design, enabling it to 'land' on the water and cruise safely even if one system fails."

Feature 2 — Ability to Discharge the Equivalent of Half a Swimming Pool's Water in One Minute

The water inlet located at the center of the aft foil draws in and then discharges 180 t of water every minute, which is equivalent to approximately half of a 25 m x 10 m x 1.5 m swimming pool. The highly pressurized nature of the water being drawn in and discharged enables the vessel to reach its top speed of 45 knots (83 km/h) in just three minutes.

How the Ship "Takes Off"

Hullborne Mode

When JETFOIL is in hullborne mode, it sails at around 10 knots (18.5 km/h), and the forward and aft foils are retracted.

Rising to the Surface

By lowering the foils and gaining speed, lift is generated via the foils, making the vessel begin to rise toward the surface at 15 knots, with the hull emerging from the water at 25 knots.

Foilborne Mode

Once clear of the water, at 35 knots, the vessel enters into foilborne operation, which is less subject to the effects of waves. It takes one to two minutes, or 0.9 to 1.8 km, for the ship to reach foilborne mode from hullborne mode, but even when cruising at top speed, the JETFOIL can come to a complete stop within about 100 m.

SERVING SOCIETY WITH TECHNOLOGY

Leveraging the Strength of Kawasaki Against the Novel Coronavirus

Development of Test Systems Using Robots

In response to the spread of novel coronavirus infections, Kawasaki has been developing a polymerase chain reaction (PCR) testing system using the duAro collaborative dual-arm SCARA robot and producing medical face shields in our factories to reduce infections among medical personnel and support the enhancement of testing systems.

1 Introducing a Temperature Measurement System Using a Robot at Kawasaki Good Times World, Collaborating with Kobe City in PCR Testing, etc.

The automatic temperature measurement system installed at Kobe Maritime Museum/Kawasaki Good Times World.

Kawasaki has developed an automatic temperature measurement system using duAro2 and installed it at the Kobe Maritime Museum and at Kawasaki Good Times World — Kawasaki Heavy Industries Group's corporate museum — which is located in the same building. Since the museum reopened in June, all visitors have been temperature-checked to ensure the safety of visitors and staff.

The system has a no-contact temperature sensor attached to the right hand of duAro. Visitors place their hands above a height adjustment sensor to raise/lower duAro's right hand to the visitor's forehead level, which causes the temperature detection sensor to begin measurements. If the visitor's temperature is at or below the preset acceptable maximum temperature, the robot indicates that the visitor may enter by removing the bar-type barrier held in its left hand. However, if the visitor's temperature exceeds the acceptable maximum, the bar remains in place and a staff member is called to the entrance.

The temperature detection sensor.

Kazunori Hirata, Senior Staff Officer of the Precision Machinery & Robot Company, who was in charge of development, says, "We will continue to add improvements, such as having the thermometer position change automatically according to the height of the visitor, so that it can also be used as a fun attraction."

In addition, in June 2020, Kobe City and Medicaroid Corporation (a medical robot development joint venture of Kawasaki and Sysmex Corporation) agreed to cooperate in the further development and social implementation of (1) a remote sample collection robot system, (2) a PCR testing robot system, (3) and a monitoring/care network system for temperature measurement and meal delivery in hospitals, all using duAro.

Regarding sample collection, regulatory approval will be obtained so that doctors will be able to remotely collect nasal samples. Regarding saliva sample collection, pre-sample analysis work and transport and storage work will be automated. In addition, each process of the PCR test is automated, utilizing a robot. The number of tests processed can be increased by three to four times that of human labor. The design, production, and evaluation of these systems are planned for completion by September 2020, and operations are scheduled to begin at a facility in Kobe Biomedical Innovation Cluster beginning in October.

Yoshiyuki Tamura, Manager of the Corporate Planning Department of Medicaroid says, "By using robots to automate various tasks, we reduce the risk of infections as well as the burden of work on medical personnel, and support the expansion of PCR testing systems."

Kazunori Hirata, Senior Staff Officer
System Section 1, System Department
FA Solution Group 2
Robot Business Division
Precision Machinery & Robot Company

2 Producing Medical Face Shields and Gowns and Donating Them to Medical Institutions

Starting April 20, Kawasaki's Kobe Works and Harima Works began producing medical face shields (pictured right) and gowns to reduce transmission of the coronavirus, donating them to medical facilities. A total of 6,430 face shields were produced using a transparent pattern film used for steel processing, and 15,880 gowns were produced in accordance with the method announced by Osaka University Hospital. We donated them to Kawasaki Hospital and prefectural hospitals in Hyogo Prefecture.

Building a system to reduce infection and increase the number of tests by automating the PCR test procedure.

3 Creating a Kawasaki Products Coloring Book for Enjoying Time at Home

As more children spend time at home to reduce the spread of coronavirus, Kawasaki has published on its website a "Home Time Series" coloring book of its products. Ten products are depicted, including the Shinkansen, a motorcycle, an LNG carrier, and a BK117 helicopter. Please click on this link to view them:

https://www.khi.co.jp/stayhome_nurie/stayhome_nurie.html

Kawasaki Commences Sales of a High-Efficiency Hydrogen Liquefier

From June, Kawasaki started selling a new hydrogen liquefier, the first one developed with made-in-Japan technologies, and offering industry-leading liquefaction efficiency.

Hydrogen is a clean energy that does not generate greenhouse gases when used as a fuel for power generation or fuel cell vehicles (FCVs), the use of which is expected to reach about 300,000 tons per year*1 by 2030. Focusing on the properties of hydrogen, which can be compressed to 1/800 in volume by liquefying at minus 253°C, Kawasaki has been engaged in research and development of liquefaction technology.

This hydrogen liquefier has demonstrated its performance and reliability through continuous demonstration operation for over 3,000 hours, and various functional tests.

The main features are as follows;

- Capable of producing five tons of liquefied hydrogen per day (equivalent to fuel for 1,000 FCVs).
- Industry-leading liquefaction efficiency*2, the key factors of which are a heat exchange cycle and a liquefaction process developed by Kawasaki, utilizing technology cultivated in our development of high-speed rotating machines such as gas turbines for power generation and jet engines for aircraft.
- Production of high-purity hydrogen (99.999%*3) and realization of easy maintenance, due to the elimination of impurities in the hydrogen liquefaction process.
- Compact layout due to the vertical structure of the liquefier (earthquake-resistant design).
- Prompt start of liquefaction within 24 hours*4 after plant start-up.

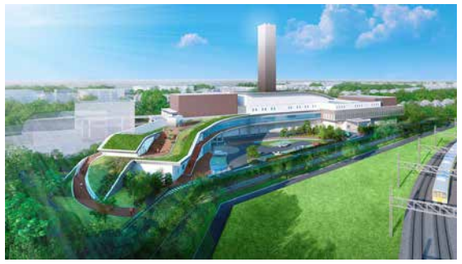
*1 2017 Renewable Energy/Hydrogen Energy Ministerial Meeting on "Hydrogen Basic Strategy"
*2 Kawasaki proprietary research
*3 This does not require a high-purification process and can be used in a fuel cell just by vaporizing it.
*4 Depending on the actual conditions, it may take more than 24 hours.

Kawasaki Awarded Contract for New Waste Treatment Facility

Kawasaki has been awarded a contract by the Kodaira, Murayama, Yamato Hygiene Association (Tokyo) for the New Waste Treatment Facility Construction and Operation Project (tentative name). This will be a design-build-operate (DBO) project in which Kawasaki will demolish and remove existing facilities, design and build new waste incineration and processing facilities, operate the new incineration facilities for 20 years and 6 months, and operate the non-combustible and bulky waste processing facilities for 24 years.

During this scrap-and-build project planned for execution in phases, Kawasaki will demolish two waste incineration facilities and a bulky waste processing facility situated in a very limited space adjacent to a quiet residential neighborhood, then proceed to build the new waste incineration facilities. All demolition and building work will be completed by the end of FY 2027.

The new waste incineration facilities will be capable of treating 236 tons of waste per day using two incinerators, each with a capacity of 118 tons every 24 hours. Incineration facilities will come equipped with leading-edge Smart-ACC®* technology and use Kawasaki's proprietary parallel-flow incinerator configuration. Each of the incinerators will combine high-temperature, high-pressure boilers and extraction condensing steam turbines for high-efficiency electric power generation that supplies all the electricity the facility needs. In addition, surplus power will be sold in quantities sufficient to supply approximately 8,100 general households annually.



Simulated image of completed facilities

The facilities will feature an architectural design that harmonizes with nearby sites, such as the Tamagawa Josui Scenic Road and Nobidome Canal Historical and Environmental Preservation Area, and will provide spaces for relaxation and interpersonal exchanges that can be visited by the public. In these ways, Kawasaki hopes to achieve familiarity and acceptance among locals for the new facilities, and replace the negative image fostered by conventional waste treatment facilities, while creating an open waste treatment center that contributes to the area as a hub for regional exchanges, disaster-prevention efforts and environmental education.

* Smart-ACC: Smart Automatic Combustion Control. Proprietary, sophisticated combustion control technology by Kawasaki, designed to achieve more efficient and reliable power generation than conventional waste treatment facilities. Enables adjustment of power output at a scale roughly double that of conventional systems (over the same time period), facilitating response more closely tailored to power supply demand.

Kawasaki Receives 2020 MEXT Commendation for Science and Technology

Kawasaki engineers have been awarded the Prize for the 2020 Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (MEXT), in recognition of the company's successful development of a high-power, high-fuel-efficiency supercharged engine for large motorcycles.

Kawasaki's development of a supercharged engine for large motorcycles was achieved by bringing together various in-house technologies from areas including gas turbines and gas engines. The supercharger and engine were developed simultaneously. Kawasaki has received much praise for the resulting motorcycle engine, which fulfills essential requirements with its light weight, compact design, and agile response, while delivering high power and high fuel efficiency. The engine is currently being used in the Ninja H2R, Ninja H2, Ninja H2 SX and Z H2.

Satoaki Ichi made a short comment on behalf of Kawasaki: "It is a true honor to be selected for this commendation. I consider this a recognition of the hard work of everyone involved in the development project. Following this commendation, we will continue to refine our technologies while pursuing further development of motorcycles that meet the increasingly diverse needs of customers, and contribute to a better future for our global environment."

Ninja H2R/Ninja H2 (supercharged engine models)

Ninja H2 SX/Z H2 (supercharged engine models)

Supercharged engine for large motorcycles (Ninja H2R)

Commendation Overview

Prize name: 2020 Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (Award for Science and Technology, Development Category).
Achievement: Development of a high-power, high-fuel-efficiency supercharged engine for large motorcycles.
Recipients: the following five employees:

1. Research & Development Division, Motorcycle & Engine Company
   Satoaki Ichi (Manager, Section 1, Innovation Department)
   Hiroyuki Watanabe (Manager, Section 2, Design Department 1)
   Kazuki Arima (Senior Staff Officer, Section 1, Testing Department 1)
2. Technical Institute, Corporate Technology Division, Head Office
   Masahito Saito (Manager, Section 1, Thermal Systems Research Department)
   Kazuo Tanaka (Manager, Section 3 Thermal Systems Research Department)

Successful Test Flight of a Large Hybrid Drone

In May, a large hybrid drone being developed by Kawasaki has successfully hovered.

The test model measures about 7 m long, 5 m wide and 2 m tall, and the purpose is to test the technical possibility of a payload capacity over 200 kg with a cruising range over 100 km, and further, to evaluate the product marketability as a "flying pickup truck." Three of our high-performance Ninja ZX-10R motorcycle engines are used to generate electricity for the eight electric motors with propellers.

Unlike regular drones that rely on battery power alone, this large hybrid drone uses power generated by gasoline engines, enabling it to maintain high power output for a long time. Transportation of goods over short to medium distances via helicopter tends to be expensive, so this large drone is positioned as a low-cost aerial goods-transportation solution, filling the gap between helicopters and small drones.

From concept development to design and production, the test model was completed by the Motorcycle & Engine Company, with the cooperation of the Aerospace Systems Company and the Technology Development HQ, with the aim of confirming the feasibility of the hybrid system.

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