

Scope

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Picking Robot : The Unique Shape of Things to Come

Ultrahigh-Speed Robot Hard at Work on a Wide Array of Lines

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About the Cover

Moving quickly across the conveyor belt, the YF03N employs vacuum suction to pick up the colorful CD cases one by one.

KAWASAKI HEAVY INDUSTRIES, LTD.

Scope

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A leading supplier of industrial robots to factories around the world, Kawasaki has been at the forefront of robotics research and development for more than 40 years. For manufacturers, these robots are the perfect solution to a host of production needs from assembly to handling, welding, coating, sealing and more.

This issue's *Frontline* features the YF03N, a high-speed picking robot designed to perform a wide array of tasks on food, drug, cosmetics and even solar panel production lines.

● Three Long Arms

This industrial robot features a unique rounded body fitted with three long arms. The robot's arms come together at an end effectors, enabling it to grab a variety of objects and to quickly sort or pack with a high degree of accuracy.

Look closely at the robot's arms and you'll see that each of them is composed of a pair of rods. The arms are often referred to as legs when the robot is installed over a production line conveyor belt, but these legs can carry just about anything.

● A.K.A. Parallel Link Robot

A conventional industrial robot employs a design that resembles a human arm. It has motors in

its joints that act just like the joints of the human body, such as the shoulder, elbow and wrist. Their movements mimic arm movements, and as they perform various tasks, their joints bend. Because of this jointed structure, these machines are known as articulated robots. This design is also called a serial link mechanism, because the motors employed in the joints are serially connected.

This YF03N robot doesn't really fit this mold since its arms are actually connected in parallel and controlled individually by motors installed in the main unit. Like other robots that employ this mechanism, it is known as a parallel link robot.

The parallel link mechanism allows motion with high acceleration and deceleration, giving the robot high rigidity and the ability to work

The ends of the three long arms extending from the robot's main unit meet.

fast. Since its arms can be operated in a coordinated manner, it can also perform more complex movements.

While articulated robots have the upper hand when it comes to tasks like automotive welding and coating, parallel link robots provide an optimal solution for automating processes that are still often performed manually or that require special equipment. They are ideal for sorting and packing small objects on a conveyor belt.

● **Extremely Fast and Accurate**

One of the YF03N robot's greatest features is that it works extremely quickly. The secret to its high-speed motion lies in its lightweight carbon fiber-reinforced plastic (CFRP). Since it requires

so little power to move, most of the motor power can be distributed to the ends of the arm. The high strength and high rigidity of the CFRP arms give the robot an impressive 3 kg payload capacity. The robot's large 1300 mm work envelope, with a 500 mm vertical Z stroke, makes it suitable for a wide range of applications in a myriad of production processes.

Equipped with a small motor and reducer at the end of its arms, the robot delivers extremely high repeatability to ensure precision pick-and-place handling for maximum productivity. Mounting the motor and reducer at the end of arms has enabled Kawasaki to do away with the center shaft (spline shaft), which is normally used to transmit power from the main unit to

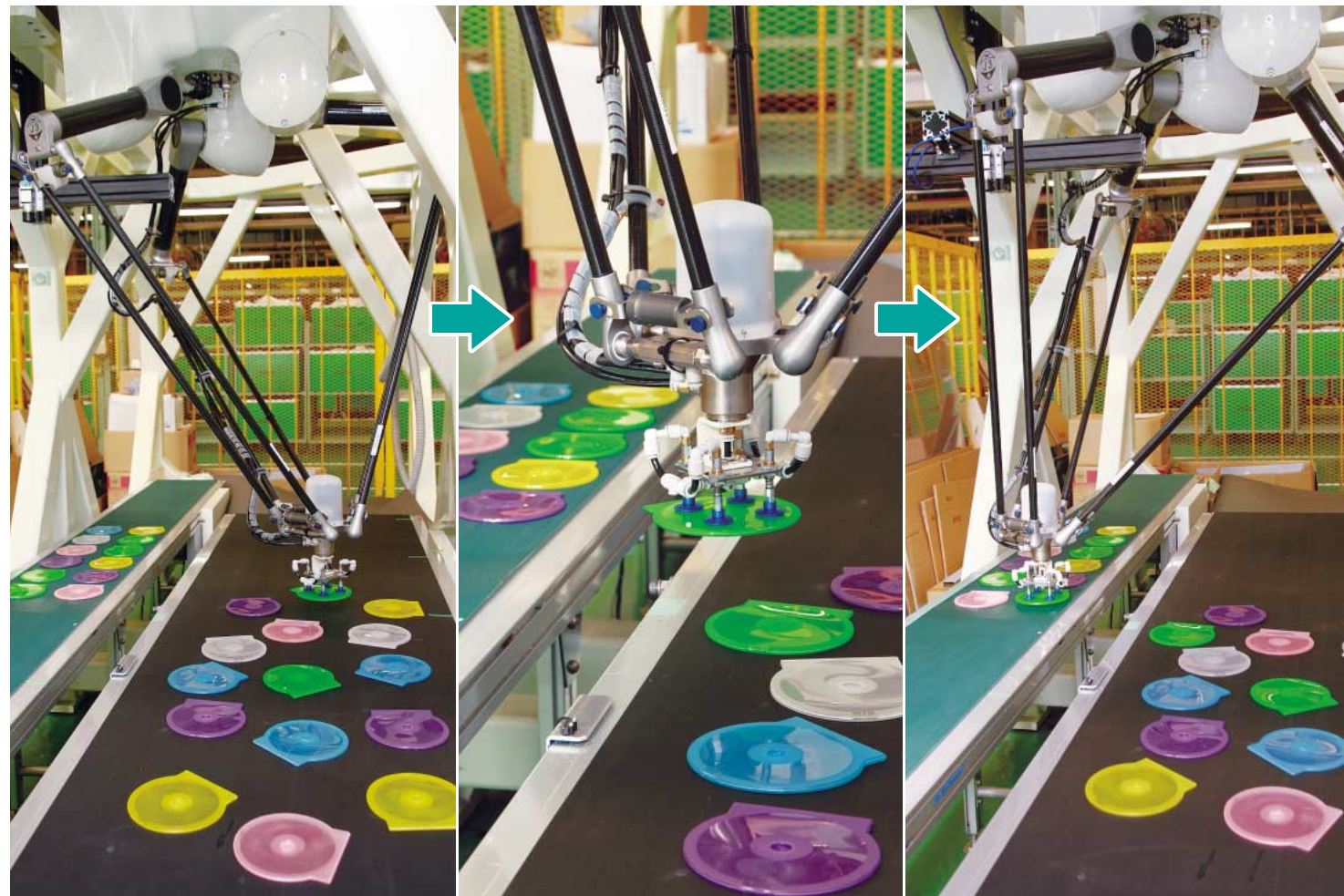
the end of the arms in conventional parallel link robots. This shaft-free design eliminates the need to replace shaft parts and allows for easy maintenance.

● **Ensured Safety in Food-Handling Applications**

Equipment and machines used in food manufacturing processes need to be washed at least once a day in order to ensure proper sanitation and safety. The YF03N offers several features that make it ideal for food-handling applications. Its component materials are designed to be washed down with acid or alkaline solutions and the main unit has a smooth surface that prevents any cleansing



The robot can pick up objects of various sizes, either soft or hard, such as solar panels (left), food products like these containers of orange gelatin (center), and disposable chopsticks packaged in paper sleeves (right).



The robot uses vacuum suction to grab packaged compact disc (CD) cases placed randomly on a conveyor belt.

The CD case is lifted and transported.

The robot places the CD case in a designated location, neatly aligned with the other CD cases. The robot performs these steps with ultrahigh speed and extreme accuracy. The three arms appear to freely expand and contract as they move back and forth.

● All of the photos in this article were taken at the Akashi Works.

solution or dust buildup. The robot uses class H1 oil and grease certified by NSF International, a globally recognized public health and safety certification organization, to ensure safety in the unlikely event that lubricant accidentally comes into contact with food.

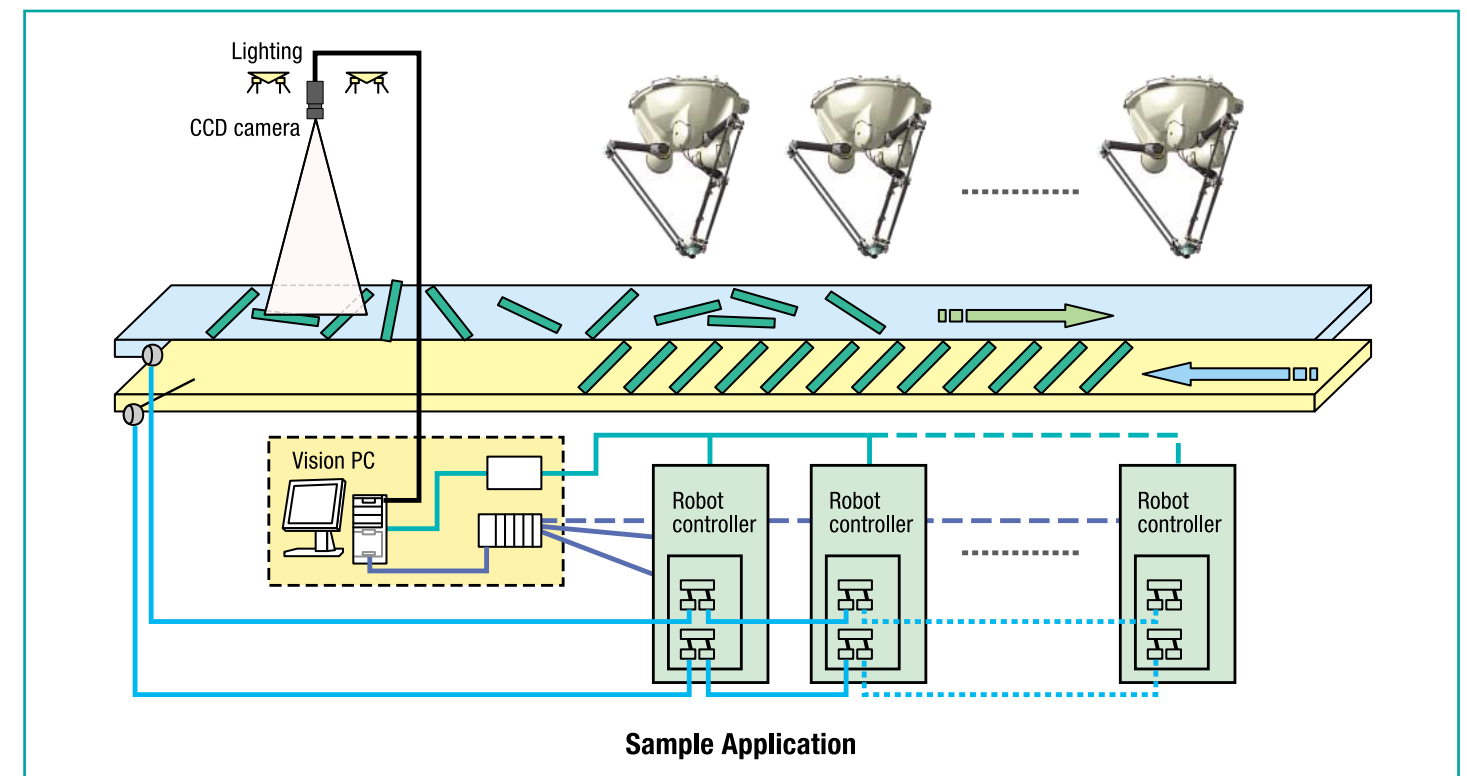
A built-in vacuum device enables the robot to pick up objects via air suction. The YF03N model also features add-ons designed to meet a host of specific requirements.

● **Targeting Food, Drug, Cosmetic and Solar Cell Production Lines**

The FY03N is often used in combination with a CCD vision camera, which identifies objects randomly placed on a conveyor belt to synchronize the robot's movements with the movement of the conveyor. This allows it to transfer objects from an incoming conveyor to an outgoing conveyor, to align them correctly on the conveyor belt, or to

pack them in cartons.

Kawasaki is focusing its sales efforts on the food, drug, cosmetic and solar panel industries, where the YF03N is used extensively. It has already become the robot of choice for an increasing number of food manufacturers. A full battery of rigid application tests using food samples provided by prospective customers is currently underway at Kawasaki's Akashi Works.



Inside the New PA-5 Rail Car Linking NY and NJ

Offering Optimum Safety and Comfort

Kawasaki is now in the process of manufacturing and delivering the new PA-5 rail cars to the Port Authority Trans-Hudson Corporation (PATH), a subsidiary of the Port Authority of New York and New Jersey. Kawasaki received this order for 350 PA-5 cars from PATH through Kawasaki Rail Car, Inc. (KRC), its American subsidiary based in Yonkers, New York. PATH is phasing the new PA-5 rail cars into service as they roll off the production line.

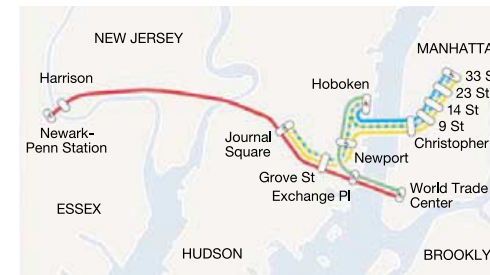
Stainless steel is used in the carbody of the PA-5, which is equipped with highly reliable controls, as well as HVAC, door operating and public address systems and other features that enhance rider safety and comfort.

Carbody manufacturing and assembly of the PA-5 is all done at the Kawasaki Motors Manufacturing Corp., U.S.A. (KMM) plant in Lincoln, Nebraska. Equipment installation, final assembly and testing are then performed at the KRC Yonkers plant prior to delivery to PATH.

PATH's Entire Fleet Will Soon Be Kawasaki-Made

Kawasaki is employing the latest technology to produce these PA-5 cars while adhering to specific state and federal procurement guidelines. All 350 of the rail cars are slated for delivery by the spring of 2012. Kawasaki has so far delivered 94 PA-4 rail cars to PATH and overhauled 248 of PATH's aging PA-1, 2 and 3 cars that are now part of the current fleet.

PATH will continue phasing the new PA-5 cars into service as they are delivered, gradually replacing aging rail cars in its existing fleet. Once delivery is complete, PATH's entire fleet will be composed entirely of Kawasaki rail cars. PATH's investment speaks volumes about its trust in Kawasaki products.



Port Authority Train-Hudson (PATH)
PATH is a rail car service operating between New York and New Jersey that spans a route that is approximately 22.2 km long.

Operator's cab

The operator's cab is designed for optimal visibility. The front windshield, featuring a built-in defrost system, is also coated on the inside with shatterproof film.

Operator's seat

1 Master Controller
The operator pushes the master control lever forward to accelerate, pulls it back to brake, and positions it in the center for neutral. The further the lever is pushed forward the faster the train will go. When the operator moves the lever it sends an electrical signal that triggers the control system to speed up or slow down the train.

2 Maintenance Diagnostic System (MDS)
The MDS detects device failures during operation and logs fault data. This data can be retrieved later at the rail yard by wireless access.

3 Automatic Train Control (ATC)
The ATC is an on-board automatic control system designed to assist the operator.

Side destination sign

Destination displays employing light-emitting diodes (LEDs) are installed on both sides of the carbody.

Front destination sign

An LED front destination sign is provided on the cab end of lead cars.

Wheelchair-accessible design

The passenger compartments have wider aisles and areas reserved for wheelchairs.

Public address system

The public address system uses digital transmission technology.

Interior information sign

Each passenger compartment interior features two LED displays that provide information about train destinations, the next stop, time and more.

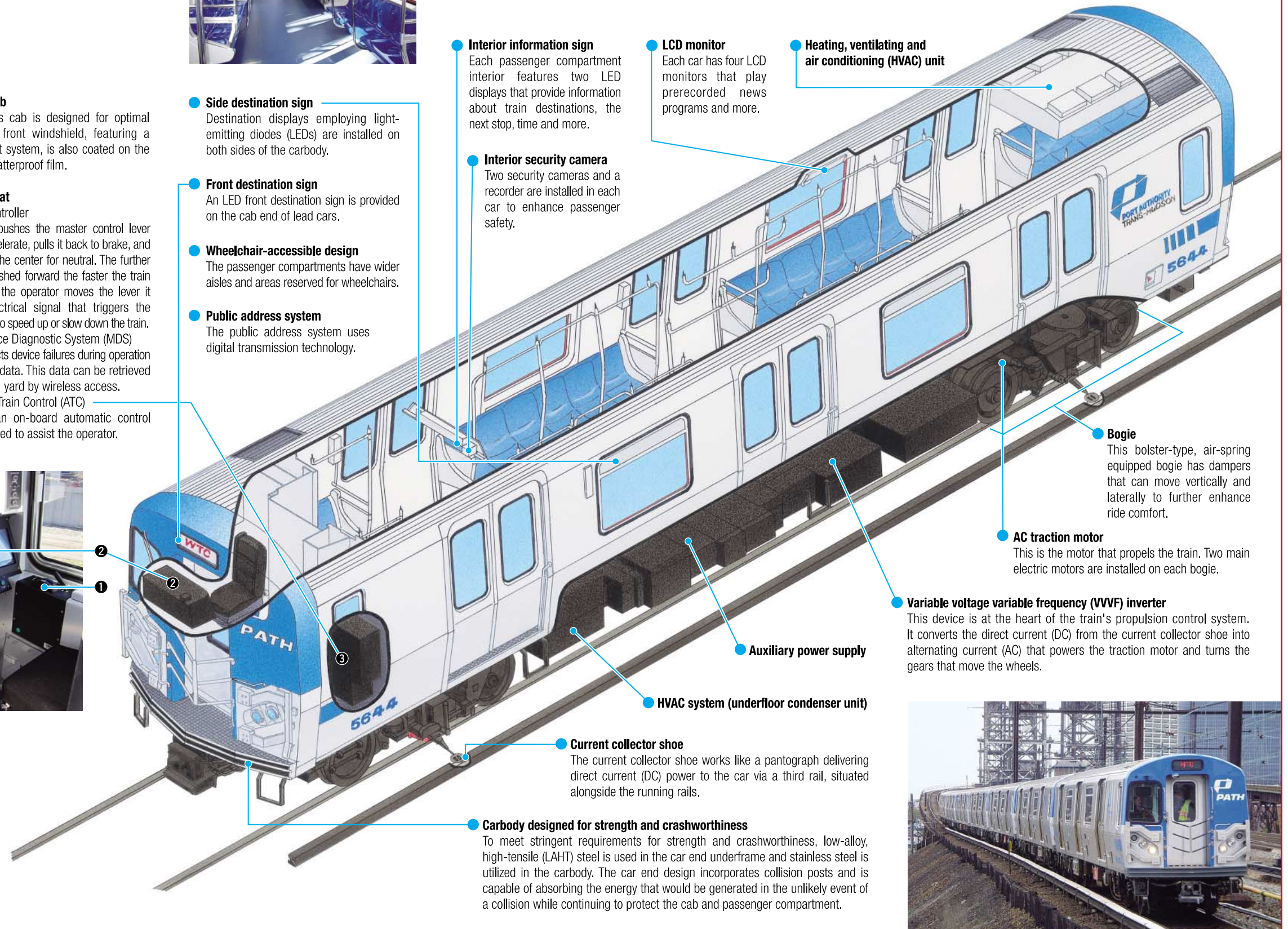
LCD monitor

Each car has four LCD interior monitors that play prerecorded news programs and more.

Heating, ventilating and air conditioning (HVAC) unit

Interior security camera

Two security cameras and a recorder are installed in each car to enhance passenger safety.



Bogie

This bolster-type, air-spring equipped bogie has dampers that can move vertically and laterally to further enhance ride comfort.

AC traction motor

This is the motor that propels the train. Two main electric motors are installed on each bogie.

Variable voltage variable frequency (VVVF) inverter

This device is at the heart of the train's propulsion control system. It converts the direct current (DC) from the current collector shoe into alternating current (AC) that powers the traction motor and turns the gears that move the wheels.

Auxiliary power supply

HVAC system (underfloor condenser unit)

Current collector shoe

The current collector shoe works like a pantograph delivering direct current (DC) power to the car via a third rail, situated alongside the running rails.

Carbody designed for strength and crashworthiness

To meet stringent requirements for strength and crashworthiness, low-alloy, high-tensile (LAHT) steel is used in the car end underframe and stainless steel is utilized in the carbody. The car end design incorporates collision posts and is capable of absorbing the energy that would be generated in the unlikely event of a collision while continuing to protect the cab and passenger compartment.



Contracts Signed for Russian Cogeneration Project

Kawasaki and Sojitz Corporation recently reached an agreement with the Far Eastern Center for Strategic Research on Fuel and Energy Complex Development (FEC), a Russian government affiliate, to proceed jointly with cogeneration projects for the Russian Far East. Contracts were signed with FEC to supply cogeneration systems for pilot plants as well as a framework contract for the first phase.

As a key component in Russia's energy and environmental strategy, the project is designed to bring highly efficient cogeneration systems to municipalities located along a 1,800 km natural gas pipeline now under construction. Scheduled for completion in 2012, the pipeline will link Sakhalin with Vladivostok via Khabarovsk. The cogeneration systems will replace aging coal-fired boilers currently being operated, and provide a steady supply of electricity and hot water while significantly cutting carbon dioxide emissions.

The pilot plants will be built in Tsimmermanovka and Khor in the Khabarovsk region. Kawasaki and Sojitz will supply five

gas turbine power generation systems and ancillary facilities to Vladivostok-based Eastern Industrial Group Co., Ltd. Tsimmermanovka's two 1,500 kW cogeneration systems are scheduled to go on line in 2012 while the three 7,000 kW cogeneration systems in Khor will begin operating in 2013.

The subsequent first-phase plan includes the delivery of 30 Kawasaki gas turbine power generation systems as well as ancillary facilities



procured by Sojitz, valued at approximately 20 billion yen, between 2012 and 2014.

Expectations are running high that the project will attract new industries to the Russian Far East and reverse the region's population decline. Once the first phase is completed, Kawasaki and Sojitz will move forward to take the project to the next phase and beyond.

An earlier bid awarded to Kawasaki and Sojitz for the provision of seven cogeneration systems to be used at the 2012 APEC summit site on Russky Island, Vladivostok, was key to winning these most recent contracts. Kawasaki currently claims the largest share of the global market for small and mid-sized gas turbine power generation systems.

Kawasaki and Sojitz have set their sights on the growing number of opportunities in Russia as this country with the largest natural gas reserves in the world looks for highly efficient and environmentally friendly natural gas-fired cogeneration solutions to power its future. ::

Korean Plant Expansion Boosts Hydraulic Equipment Production

Flutek Co., Ltd., Kawasaki's Korean subsidiary specializing in hydraulic equipment production, sales and services, recently expanded its hydraulic pump facility. The expansion, which doubles the current production capacity, is designed to meet the growing Korean market demand for pumps used in construction machinery.

Kawasaki acquired a controlling interest in Flutek in 2003 after years of providing technical assistance to the company as a partner and distributor of its hydraulic products. Since



coming under the corporate umbrella, Flutek has served as Kawasaki's production, sales and customer service base in Korea.

The new production facility has been constructed on the premises of Flutek's Uiryeong Plant, located 60 km northeast of Changwon City. Boasting a total area of 13,200 m² with a floor area of 7,600 m², the facility is equipped with new equipment as well as a hydraulic pump assembly line transferred from Flutek's Changwon Plant. Uiryeong is moving ahead with knockdown production of hydraulic pumps using core parts supplied by Kawasaki's Nishi Kobe Works.

Construction machinery manufacturers across Korea are gearing up production of hydraulic excavators as they move into the Chinese market, where rapid economic growth is fueling a need for greater infrastructure development. While demand for hydraulic

construction machinery equipment is rising in Korea, the Chinese hydraulic excavator market has now become the largest in the world. Continued growth over the medium-to long-term is expected due to ongoing infrastructure improvements to irrigation, gas, electricity and transportation networks in China's underdeveloped northeastern and inland regions.

Kawasaki will continue to leverage the latest developments in technology to provide reliable, high-performance products to the ever-expanding global hydraulic equipment market. ::

About the New Production Facility

Address: Samga ri 79-2, Bongsu Myeon, Uiryeong Gun, Kyungnam, Korea
Product lines: Hydraulic pumps, component processing, heat treatment
Production capacity: 4,000 units/month
Total floor area: Approx. 7,600 m²
No. of employees: Approx. 56 (as of October 31, 2010)

Rexpeller Orders Received for Drillships and Shuttle Tankers

Kawasaki recently received orders for Rexpeller units for two drillships and two shuttle tankers to be used in an oilfield development project being conducted by Petroleo Brasileiro S.A., Brazil's state-owned oil company. The order comes from Samsung Heavy Industries Co., Ltd. in Korea.

The Rexpeller is a fully azimuth-steerable thruster that can generate thrust in any horizontal direction and be utilized as a propulsor, rudder and side thruster. Its excellent maneuverability has made it the perfect propulsion solution for mainly tugboats and supply boats.

Drillships are used upstream in the petroleum business to drill offshore for oil. Samsung ordered 12 Rexpeller units for two additional drillships, to serve as the ships' main propulsion systems. This brings Samsung's order for Rexpellers to a total of five drillships, including three ships for which it had placed a previous order. The units are all Kawasaki's proven KS-320LF/AU (driving force: 4,500 kW), the

company's largest model yet to be deployed. Delivery to Samsung is scheduled for 2012.

Shuttle tankers are used midstream in the petroleum business to transport oil from



offshore facilities, where it is produced, stored, and offloaded, to onshore oil refinery terminals. Kawasaki will provide six side thrusters, as well as four Rexpellers. Delivery to Samsung is scheduled for 2011.

Rexpellers ensure that the drillships and shuttle tankers maintain the exact same locations while they're drilling/offloading, and are also designed to be retractable during shuttling to prevent underwater drag. Kawasaki has delivered more than 500 units since their initial launch in 1983, and has successfully delivered more than 3,000 side thrusters since 1967. These latest orders are a testimony to Kawasaki's record of successful deliveries backed by superior engineering expertise and superior after-sales service.

As global demand for energy grows and the development of ocean resources expands, Kawasaki will continue to pursue sales of its Rexpeller for use in shuttle tankers, drillships and other large-size ships used in the petroleum and natural gas industries. ::

H-IIB Launch Vehicle Fairing Delivered

Kawasaki shipped a payload fairing (PLF^{*1}) for the H-IIB Launch Vehicle No. 2 to the Japan Aerospace Exploration Agency (JAXA) ahead of the successful January 22 launch of JAXA's HTV-2^{*2}. After design and manufacturing of the PLF at Kawasaki's Gifu Works, the fairing was assembled and shipped from its Harima Works. Upon arrival at JAXA's Tanegashima Space Center, the PLF was incorporated into the H-IIB Launch Vehicle No. 2 in preparation

for the upcoming launch.

The 5S-H PLF is an extended version of the 5 m single (5S) model designed for the H-IIA Launch Vehicle. It features a 15 m long cylinder, which is 3 m longer than the 5S model, as well as a reinforced structure that is designed to withstand an increased payload weight. The 5S-H PLF carries one HTV.

Since delivering the first PLF for the H-II launch vehicle in 1993, Kawasaki has

supplied payload fairings for a total of seven H-II launch vehicles. In order to meet a broad range of payload specifications, such as the launch of large satellites as well as the simultaneous launch of two satellites, Kawasaki has developed and manufactured a wide spectrum of PLFs for H-IIA launch vehicles, including 4 m single (4S), four-meter dual (4/4D), and 5 m single fairings (5S). In addition to

supplying these PLFs — which have been a key component in 18 different launch vehicles to date — Kawasaki also supplied the PLF for the H-IIB Launch Vehicle No. 1.

Kawasaki is playing a vital role in today's satellite launch industry via the development and production of cutting-edge PLFs. ::

*1. A payload fairing is an enclosure installed at the tip of a launch vehicle that protects the satellite from aerodynamic heating, acoustic noise and vibration during liftoff. After the launch vehicle leaves the earth's atmosphere, the fairing splits in two and is jettisoned, allowing the satellite to separate from the launch vehicle.

*2. The H-II Transfer Vehicle (HTV) is an unmanned cargo transporter developed in Japan that was designed to deliver supplies to the International Space Station.

Overview of PLF for H-IIB Launch Vehicle No. 2

Type: 5 m extended fairing (5S-H)
Length: 15 m
Diameter: Approximately 5.1 m
Payload: HTV exclusive



Mega Class Urea Plant Up and Running in Pakistan

Sojitz Corporation and Kawasaki recently completed commissioning and performance tests for a new urea plant in Pakistan. The new plant is the core facility of a fertilizer complex operated by Fatima Fertilizer Company Ltd., a Lahore-based company operating under the umbrella of the Fatima Group, one of Pakistan's largest industrial conglomerates.

The fertilizer complex, constructed by Fatima Fertilizer near Sadiqabad, a city in central Pakistan, will produce urea as well as various other synthetic fertilizers from ammonia using natural gas produced in the nearby Mari Gas Field. The facility, with a daily urea production capacity of 1,500 tons, is one of the largest in the country.

Sojitz and Kawasaki were awarded a contract for this project, valued at approximately 13 billion yen, in June 2006. Sojitz was responsible for coordinating the overall contract administration process while

Kawasaki performed engineering, procurement and technical services for the urea plant in addition to project management services.

There is a growing demand in Pakistan for fertilizer, a vital material needed to maintain and fuel further development of agriculture, the country's main industry. The devastating floods that occurred last July delivered a severe blow to Pakistan's fertile farmlands. Against this backdrop, the new complex is in the national spotlight as it brings new hope for the recovery of Pakistan's troubled agricultural sector.

Sojitz and Kawasaki were also awarded a contract to build Turkmenistan's largest fertilizer production facility in December 2009. The project is currently underway with funding from the Japan Bank for International Cooperation (JBIC) and the full support of Nippon Export and Investment Insurance (NEXI). The project is expected to

rapidly boost agricultural development as well as employment in Turkmenistan.

Sojitz and Kawasaki will continue to leverage the know-how and expertise they accrue via their overseas operations as they move forward to implement projects that are helping to build a brighter future for the people of Pakistan as well as the rest of Asia and the Middle East. ::



BK117C-2 Medevac Delivered to Aero Asahi

Kawasaki recently delivered its latest BK117C-2 helicopter to Aero Asahi Corporation, for use providing emergency medical services. The new helicopter is the 17th C-2 model Kawasaki has delivered to the Japanese market.

The BK117 was developed jointly by Kawasaki and European helicopter manufacturer Eurocopter Deutschland (ECD), formerly Messerschmitt-Bolkow-Blohm (MBB). The BK117 is a medium-sized twin-engine multipurpose craft that's used for everything

from broadcasting, transporting cargo and passengers, and fighting fires, to police and emergency medical services. When employed as a medevac, the large clamshell doors at the rear of the BK117 facilitate the quick transfer of patients in and out of the helicopter. Its roomy cabin also enables the onboard medical team to easily move around as they provide care for the patient. These outstanding features as well as its compact body and superior mobility have earned the BK117 high marks around the

world, making it the bestselling emergency services model today.

The BK117 has been continually upgraded since its market debut in 1983. Cutting-edge technology and outstanding reliability have proven to be a winning combination. Kawasaki has delivered 150 BK117s, and together with those delivered by ECD, there are over 850 in use around the globe. ::

*The craft's EMS (emergency medical services) kit includes special medevac features such as a special cabin floor, a stretcher, seats for a doctor and nurse as well as a friend or family member of the patient, a wall-mounted rack for medical supplies, ceiling and wall rails, a forward-mounted medical cabinet, lights and a dedicated power supply unit for medical equipment.

Specifications of the BK117C-2 helicopter

Length: 13.03 m
Width: 1.73 m (body)
Capacity:
 11 (maximum number of seats)
Maximum load: 3,585 kg
Cruise speed: 246 km/h
Cruise range: 675 km (standard tank)
Major equipment: automatic pilot system, rescue winch, repair kit, etc.



Kenryu Submarine Launched

A launch ceremony was held for the submarine *Kenryu*, which was built for the Japan Ministry of Defense (MOD) at Kawasaki's Kobe Works, on November 15. The ceremony was attended by a delegation of top Japan Defense Agency officials.

The submarine is the fourth Soryu-class submarine built by Kawasaki, and the 25th built at the Kobe shipyard since World War II. With a hull of high-tensile steel, it provides superior submerged operations and propulsion performance, and also features Stirling engines for increased underwater endurance, a variety of automated systems, improved surveillance capabilities using high-performance sonar, increased stealth capabilities, and enhanced safety measures. ::



W800 Sport Model Rides Like a Vintage Motorcycle

Kawasaki launched the new W800 — a motorcycle that recreates the ride and beauty of a vintage bike — in Japan in February, marking the latest evolution of the W series. The origins of the series can be traced to the W1, which made its debut in 1966 and boasted the largest engine capacity of any Japanese motorcycle at the time. The W1 also laid the foundation for Kawasaki's subsequent rise as a manufacturer of large motorcycles and inaugurated a brand that has matured over the long course of 45 years. Its continuing legacy now thrives with the W800.

With an air-cooled, parallel twin-cylinder

SOHC 4-stroke engine (773 cm³), the W800 inherits the W series, traditional vertical twin*. Its engine generates a maximum torque at 2,500 rpm to provide not only power and control at low- and mid-range engine speeds but also a comfortable vibration and deep throb. With a fuel-injection system, the W800's advanced air-fuel ratio control realizes superior environmental performance to ensure compliance with the new Japanese emissions regulations. It also realizes easy handling thanks to its combination of narrow, large-diameter tires and traditional-style suspension.

From the chrome-plated emblem that

proudly adorns the W800's slender fuel tank to its deeply pleated tuck-and-roll seat, the simple yet elegant design of the W800 bespeaks the eternal beauty of motorcycles. Its generous use of chrome and polished metals on the front fender and other parts gives it a luxury feel and makes its carefully finished, high-gloss surfaces glow.

Kawasaki also released the W800 Special Edition, which features an all-black engine and other exterior parts, and wheels with gold-colored rims. ::

*A parallel twin-cylinder engine in which the cylinders are placed in an upright position.



W800



W800 Special Edition

Kawasaki Gallery Heizo Kanayama's World



First Cherry Blossoms, 1954, 40.7 x 53.0 cm, oil on canvas, from the collection of the Hyogo Prefectural Museum of Art.

A Vibrant Cherry Tree Brightens the Overcast Skies

Shusaku Sagara, Associate Curator, Hyogo Prefectural Museum of Art

Kanayama Heizo Gashu (The Art of Heizo Kanayama), a voluminous book published by Nichido Shuppan (Edition Nichido) in 1976, is still the most authoritative study of the artist's work. According to the chronological table appearing at the end of the book, Kanayama painted the scene shown here between April and May 1954, while staying in Towada, a town located in northern Japan. In a letter to his wife, Raku, penned long before completing the painting, Kanayama complained of the bitter cold and a lack of snow that would provide the wintery scenery he was hoping to capture on canvas.

Here we see a depiction of cherry trees standing against a

watery background, presumably Lake Towada. The painting is an excellent example of the artist's skilled brushwork, with its careful rendering of the reflection of the distant mountain ridge on the water's serene surface. The dull, gray, cloud-covered sky occupying most of the canvas stands in stark contrast to the vital colors of the cherry trees, painted with the bold brushstrokes that would become a signature characteristic of Kanayama's later works. The juxtaposition of the serene sky and water in the background underscore the jubilant life force in the spring blossoms that have emerged from the long, cold, northern winter.



Heizo Kanayama and Kawasaki

Heizo Kanayama (1883 -1964) went to Europe in 1912, after graduating at the top of his class from the Tokyo University of the Arts. He won the second prize at the Ministry of Education Art Exhibition in 1916, and went on to create many masterpieces in which nature is a recurring theme. Kanayama left an indelible imprint on the history of modern art in Japan.

The Shipyard, exhibited at the Ministry of Education Art Exhibition in 1917 (and featured in *Scope 83*), is the work that first brought Kawasaki and Kanayama together. Toward the end of Kanayama's life, Kawasaki agreed to the artist's request to permanently house 138 pieces of his artwork. Kawasaki has since donated a major portion of this collection to the Hyogo Prefectural Museum of Art.