The Kawasaki Group creates new value by channeling its engineering prowess into various fields, including land, sea, and air transportation systems, energy and environment, and industrial equipment, and also by pursuing synergy that goes beyond the boundaries of these respective fields. Kawasaki strives to maintain harmony with the global environment as it works toward its vision of a better future.

Kawasaki, working as one for the good of the planet

1. Medical & pharmaceutical robot
2. Gas turbine for power generation
3. Boeing 787 Dreamliner
4. Systems for hydrogen liquefaction
5. NEW generation high-speed train
6. Cement plant
7. Gas engine for power generation
8. Ninja H2R
9. LNG carrier

Kawasaki Heavy Industries, Ltd.
Kawasaki’s Century-Old Business Takes on New Fields

Kawasaki’s hydraulic equipment business has set out toward its next centennial. A global leader in hydraulic equipment for excavators, the company is now seeking to build on its success by making inroads into new fields. A new innovation for work vehicles is just around the corner.

Tackling HST and Other New Fields
Construction machinery such as hydraulic excavators is the quintessential example of a work vehicle. The first hydraulic excavator made entirely in Japan—Hitachi’s (now Hitachi Construction Machinery) UH03—was developed back in 1965.

In developing the UH03, Hitachi commissioned Kawasaki to develop hydraulic motors for the travel and swing devices. After much trial and error, Kawasaki produced and delivered three hydraulic motors—left and right travel motors and a swing motor.

In the half-century since then, Kawasaki has become the world’s leader in hydraulic pumps and motors for excavators and earned the overwhelming support of customers. And this year marks the 100th year since Kawasaki entered into a technological partnership on a radial piston pump for a steering gear at Kawasaki Dockyard Co., Ltd. (now Kawasaki’s Kobe Shipyard) in 1916.

At this milestone, Kawasaki’s hydraulic equipment business has embarked on a challenge in a new field. For the first time, Kawasaki began supplying products in the field of industrial vehicles equipped with a hydrostatic transmission (HST). HST uses a closed circuit to continuously change the gear ratio only by controlling the displacement of a hydraulic pump and hydraulic motor. Examples of vehicles that use a closed-circuit hydraulic system include wheel loaders and tractors.

The first products to be released in this category are the K8V series of swash plate type HST pumps and the M7V series of swash plate type axial piston motors.
Hydraulic pumps that provide the energy to drive motors and cylinders through hydraulic pressure come in two types: one for an open circuit, and the other for a closed circuit. While hydraulic excavators employ an open-circuit system, a closed-circuit system is used in various industrial vehicles. The biggest market, however, is industrial vehicles provided with an HST drive system, which include wheel loaders, tractors, and forklifts. As such, motors used in a closed-circuit system require high speed and high torque capabilities, as well as a continuously variable HST that consists of a closed-circuit system.

In an open-circuit system, hydraulic fluid leaves the tank and flows through a pump, valve, and motor (cylinder) before it returns to the tank. In a closed-circuit system, on the other hand, hydraulic fluid is circulated between a pump and motor (see Fig. 1). Although a closed-circuit is simple in structure, the pump must be fitted with various features, such as a charge pump for replenishing hydraulic fluid.

Closed-circuit hydraulic equipment is adopted in various industrial vehicles, the biggest market, however, is industrial vehicles provided with an HST drive system, which include wheel loaders, tractors, and forklifts. As such, motors used in a closed-circuit system require high speed and high torque capabilities, as well as a pump for generating force: K8V pumps supply hydraulic fluid at a pressure of 40 MPa. They not only boast the world’s top-level pump efficiency, which impacts the vehicle’s fuel efficiency, but also achieve low noise and high reliability, responding to the needs of industrial vehicles.

M7V motors receive the force of hydraulic pressure generated by a K8V pump to produce high speed and high torque. Compared to a motor for hydraulic excavators, which is capable of operating at approximately 2,000 rpm, a motor for HST can run at 5,000 rpm, nearly doubling the power density (power per unit weight).

HST motors use hydraulic fluid sent from the pump to the swash plate, that presents another challenge in constructing the internal structure.

Despite these challenges, the K8V series achieves the world’s highest pump efficiency and low noise. To increase efficiency, both the clearance between the cylinder block and pistons and frictional force were minimized. By using highly heat-resistant piston materials to reduce the clearance, the amount of hydraulic fluid leaking from the clearance can be reduced. This will enable the pump to supply hydraulic fluid more efficiently, and high power can be ensured even when the pump is reduced in size. To reduce noise, the shape of the valve plates that control the timing at which pistons take in and discharge oil was re-examined. Noise is generated as a result of the pressure change that occurs inside the piston chambers. Thanks to the newly redesigned valve plates, the timing in which hydraulic fluid is taken in and discharged was optimized.

The structures of pump and motor are both based on a cylinder block that has numerous holes in which pistons move. Their basic structure is the same. The pump rotates using the engine’s torque, and the motor generates torque by using high-pressure hydraulic fluid. Both the pump and motor have a drive shaft, which is engaged with a swash plate set at an angle to take in and discharge oil, generating high-pressure hydraulic energy. On the other hand, the motor generates torque by using high-pressure hydraulic fluid to press the pistons against the swash plate.

The art of controlling oil is illustrated in Figs. 2 and 3, swash plate type pumps and motors are like twins. Both have common technological challenges as well as their respective challenges.

Common technological challenges include high-speed rotation, high pressure, large swash angle, and weight reduction. These challenges are actually closely related. Masaki Ohnishi, Senior Manager of the Engineering Division of Precision Machinery Company, explains as follows: “By increasing speed and torque, the amount of heat generated will inevitably increase as well, which means that sliding components where parts rub against each other must use materials with greater heat resistance. So our job begins with choosing the right materials, enhancing the dimensional accuracy of parts, and increasing surface hardness. We also need to adjust the balance of hydraulic pressure to ensure the shaft remains steady when rotary components such as pistons and a cylinder block rotate. Although we can increase the power density by increasing the swash angle of the swash plate, that presents another challenge in constructing the internal structure.”
The key to realizing high speed and high torque was stabilizing the cylinder block. When pistons are pushed out by hydraulic pressure and come into contact with the swash plate, they slide along its slanted surface. This motion generates torque. Accordingly, the positions of the cylinder block in which pistons are lined up must be stabilized in order to achieve high-speed rotation and high torque.

Komada explains, “To optimize hydraulic pressure balance, we fully redesigned the pistons, cylinder block, and other rotary components, and thoroughly re-examined the shape and other aspects down to the smallest detail.”

In developing pumps and motors, measurement and analysis technologies play a crucial role. In the case of pumps, for example, their efficiency is determined by volumetric efficiency multiplied by mechanical efficiency. Volumetric efficiency takes account of the loss of hydraulic fluid that leaks from clearances between parts, etc. Mechanical efficiency takes account of the loss of power caused by the sliding movement of parts and the agitation of hydraulic fluid inside the device. To improve the efficiency of both technologies to measure the amount of losses accurately and analytical technologies to theoretically explain why the losses have occurred are needed.

These technologies were supplied by Kawasaki’s Technical Institute, Corporate Technology Division. K8V motors were developed using the fluid analysis technology Kawasaki cultivated through the development of aircraft and rolling stock.

Otsuki says, “Rotary components such as pistons and cylinder blocks are the core elements of pumps and motors. The ability to accurately achieve the optimum shape obtained through measurement and analysis shows the manufacturing capabilities of the Nishi-Kobe Works. This is truly a technological innovation accomplished through the collective strengths of Kawasaki.”

As with the pump, a high-speed, high-pressure motor is subject to high heat. For this reason, materials with high resistance to heat and pressure were chosen, and the surface of the materials was heat-treated.

The challenge was in achieving this with a swash plate type motor. “Because HST travels at 40 to 50 km/hr, 5,000 rpm was a prerequisite. But the significance of this challenge was in achieving this with a swash plate type motor.”

As with the swash plate type motor, its ability to absorb strong shock, and because it is supported by the oil-film pressure generated by the swash plate, the high-torque swash plate type motor was a requisite. But the significance of this challenge was in achieving this with a swash plate type motor.”

Kouichi Komada, who was in charge of development, says, “Because HST travels at 40 to 50 km/hr, 5,000 rpm was a prerequisite. But the significance of this challenge was in achieving this with a swash plate type motor.”

Hydraulic pump operation area (left). The area around the operation device is extremely quiet as it is surrounded by soundproof walls, even though the hydraulic pumps are operated under high pressure. The completed hydraulic equipment is painted and then shaped (right).

From the Project Team

By Yasushi Sotani

Associate Officer, General Manager, Engineering Division, Precision Machinery Company Kawasaki Heavy Industries, Ltd.

Ability to Propose a Total Hydraulic System Solution Holds the Key to the Next 100 Years

The year 2016 marks the 100th anniversary of the start of Kawasaki’s hydraulic equipment business. Taking this opportunity, we have decided to expand our business into the new fields of closed-circuit systems and HST using our technological capabilities built up through the development of hydraulic equipment for excavators and our customers trust as a foundation.

The global market for hydraulic-related businesses is estimated to be in the order of 3.3 trillion yen. Kawasaki, which mainly manufactures hydraulic pumps and motors for construction machinery, is one of eight major players in this area.

As we make inroads into new fields, we must make sure our hydraulic equipment delivers unique value and is offered as a system. We must also have a decisive edge over our competitors in our ability to develop and manufacture high quality hydraulic equipment. Our expertise in hydraulic circuits and electric control circuits that are required for making machines work should also be leveraged in offering solutions to our customers. Our strength lies in our ability to offer superior equipment combined with a system that makes the most of it.

The field of HST, including wheel loaders and tractors, is a huge market, but it is also extremely competitive. That is all the more reason to focus on proposing a system solution for our customers’ machinery. Our hydraulic equipment offers world-class efficiency and performance backed by technologies developed over many years. I believe this, combined with our system solution, will enable us to compete in the closed-circuit market as well. Kawasaki is the global leader in hydraulic equipment for excavators, but our entry into the closed-circuit market and the HST field in general, which are far from our traditional areas of operation, has met with amazement among our competitors and is turning heads. For us, this was a natural choice as we seek to evolve along the way toward the next 100 years of our hydraulic equipment business. It is also a challenge to motivate ourselves for this journey.

The key to realizing high speed and high torque was stabilizing the cylinder block. When pistons are pushed out by hydraulic pressure and come into contact with the swash plate, they slide along its slanted surface. This motion generates torque. Accordingly, the positions of the cylinder block in which pistons are lined up must be stabilized in order to achieve high-speed rotation and high torque.
It was an overwhelming victory worthy of a machine developed with the goal of dominating the circuit. Riding this machine, Jonathan Rea won 14 out of a total of 26 races to become the series champion for the first time in his career. He finished on the podium 23 times, setting a new record for Kawasaki, and also won more races than any other Kawasaki riders have ever managed to achieve in one season. To top off his sensational season, he even broke the record of consecutive WorldSBK podium finishes.

WorldSBK is the world’s top motorcycle race in which competitors use machines based on commercially available motorcycles. Rea, who joined the Kawasaki Racing Team (KRT) in 2015, showed excellent chemistry with the Ninja ZX-10R and fully brought out its enormous potential, propelling the team to victory that same year. It was also a victory that seemed to promise more to come.

“First of all, I would like to thank all my teammates,” says Rea. “Each one of us is a member of the championship team, and we are all happy with this result. The Ninja ZX-10R is packed with the outstanding technologies of Kawasaki, which creates all kinds of products, and we also have excellent engineers we can trust on the team. We could not have won the championship without this perfect balance of bike and team. The great chemistry between KRT’s bike and my riding style was certainly a factor that helped me win 14 races in 2015. But more than anything else, it is the strong bond that I was able to develop with my teammates that made this happen. I would like to keep this good relationship going. I also want to thank my family for all the support they’ve given me. If it were not for my father, I would not be here today. He is the reason I started riding motorcycles, and his technical advice has always been an emotional support.” Rea’s father was also a motorcycle racer and he started taking Rea out to the paddocks at the age of two. At the age of five, Rea started riding a BMX. “My father believed that I would one day become a champion when I was around five. He was happy for me when I joined KRT, and of course, winning the championship was a truly joyful moment for my father as well. I still ride a bike at least three days a week during the off-season as part of my training. But now my training mainly consists of riding a road bike. I ride at least 50 km a day.”

When I first rode the Ninja ZX-10R, says Rea, “I was so impressed by its stability. Even when I was trying to reduce the lap time, it was so stable that it felt almost like everything was in slow motion. When I am racing aggressively, it feels like I can get even more power out of this machine, and that makes me want to ride it even more. The bike has an excellent foundation, and it has no weaknesses. It is an amazing machine that is perfectly balanced on all points. I feel that I have finally met a bike that fits perfectly with my riding style.”

Rea shared his goal for 2016: “I started my pre-season preparations a bit earlier than usual this year. I’m 1 kg lighter than I was last year, and I’m already in my best shape. I know that being the defending champion we will be heading into a tougher season than the previous one, but I will enjoy the race and aim to finish at the top with great teamwork.”

A perfect balance of bike and team was the key to winning the series championship.

Jonathan Rea
A British motorcycle racer born in Northern Ireland, and the 2015 World Superbike (WorldSBK) champion. Made his WorldSBK debut in 2008 at the Portimão season finale (round 14), where he finished 4th and 15th. Notched his first win in race 2 of the 8th round of the 2009 season at San Marino/Misano, Italy. Won the Suzuki 8-hours race held in 2012.

In 2015, the Kawasaki Racing Team won the much coveted World Superbike (WorldSBK) series championship. Jonathan Rea, who joined the team from the 2015 season, rode the Ninja ZX-10R and won 14 races.
This water-refrigerant chiller occupies a space of approximately 6.3 m², about the same size as an HFC Chiller!

**Kawasaki Water-Refrigerant Centrifugal Chiller**

**Commentary**

Hayato Sakamoto

Assistant Manager, Blower Engineering Section

Aero-Dynamic Machinery Department, Machinery Division

Kawasaki Heavy Industries, Ltd.

**Using Water, the Ultimate Refrigerant**

Air conditioners can keep a room cool or warm thanks to the work of a refrigerant, which conveys thermal energy. CFCs, which used to be a common refrigerant, have been implicated as a cause of ozone depletion and global warming, and they will be phased out completely by 2020. Today, CFC substitutes (HFCs) are mainly used as a refrigerant. While HFCs are inexpensive, easy to handle, and not easily decomposed, they are not easily decomposed and cause ozone depletion and global warming. So, is there an ultimate refrigerant that does not have a footprint on a par with existing chillers?

Kawasaki developed Japan’s first centrifugal chiller that uses water as a refrigerant. Unlike HFCs, which exist in the form of gas under atmospheric conditions, water is a liquid, and its pressure needs to be reduced in order to change phases in the evaporator and condenser, and a high pressure ratio between the evaporator and condenser needs to be achieved for the refrigerant cycle. In addition, using water as a refrigerant multiplies the volumetric flow rate 100-fold, necessitating a large compressor, which inevitably makes the chiller larger. The footprint of a chiller is a significant issue, affecting the productivity of offices and plants. To address this issue, Kawasaki developed a compressor that effectively increases pressure, drawing from its fluid analysis technology cultivated through the development of gas turbines and steam compressors. Kawasaki also developed a new high-speed motor to drive the compressor. Moreover, the components inside the chiller were also rearranged to achieve both a refrigerating capacity and a footprint on a par with existing chillers. Kawasaki’s water refrigerant chiller features a capacity of 100 USRT of refrigeration (352 kW) and a coefficient of performance (COP) of 5.1. This is the same level of performance as HFC chillers, and of course, water-cooled chillers emit no HFCs. Assuming a service life of 15 years, they will each keep 575 tons of CO₂ out of the atmosphere. Using water as a refrigerant has the added benefit of significant savings in maintenance costs. A test unit has been in operation at Kawasaki’s Kobe Works since 2013, and so far everything has been running smoothly. This demonstration test has allowed Kawasaki to amass considerable know-how regarding system installation, operation, and after-sales services.

The world’s eyes are increasingly turning to the green and cost-efficient water-refrigerant centrifugal chiller.

**Mechanism of a Water-Refrigerant Centrifugal Chiller**

Water reaches its boiling point at lower temperatures under low pressure, which is why it boils quickly on top of a high mountain. Kawasaki’s water refrigerant centrifugal chiller vaporizes water the refrigerant, at 6°C under a low pressure of 0.9 kPa (approximately a hundredth of atmospheric pressure) inside the evaporator. Water that returns to the evaporator through a pipe at 12°C is cooled by this vapor to 7°C. The resulting chilled water is used to generate cool air that keeps offices comfortable. On the other hand, the low-temperature, low-pressure steam flowing from the evaporator is pressurized by a turbo compressor to 6.3 kPa. This steam is cooled inside the condenser and returned to a liquid, which is then sent back to the evaporator. Kawasaki’s water refrigerant chiller employs two-stage compression to achieve a seven-fold pressure ratio.

**Kawasaki Technology**

**Two-Stage Compressor**

The pressure of the evaporator is approximately a hundredth of atmospheric pressure. Moreover, because the refrigerant has a large volume, the compressor must be large as well. To increase the performance of the compressor under these conditions, Kawasaki adjusted the number and shape of the impeller blades. Kawasaki also introduced further technologies, such as two-stage compression, and an intermediate cooler placed in the middle of the two-stage compression process to keep the temperature low inside the compressor. These enhancements enabled the creation of a compact, high-performance chiller.

**High-Speed Motor and Compressor**

A proprietary motor that achieves high-speed rotation. The additional speed is increased through fine control of magnetic force. The motor is integrated with the compressor and is placed in the refrigerant atmosphere. Therefore, the motor’s cost is saved with no need for insulation and to make it waterproof. Because the motor is connected directly with the compressor, there is no need for a speed-reducing gear and oil.
Yuta Tabuse accomplished the feat of winning three titles three years in a row in high school, and he is the only Japanese national to have ever played in the NBA. Now 35, he shares his thoughts on his current situation and future goals.

Success is Achieved Only through Persistent Efforts

Yuta Tabuse currently plays for the Japanese professional basketball team Link Tochigi Brex. Every day, he arrives on court two hours before training begins. He is always the first to arrive, and he quietly goes through his warm-up routine. At age 35, he is the eldest player in the team. A living legend who was hailed as a phenom, Tabuse is now more absorbed in basketball than he has ever been in his life.

“You have more things to do as you get older,” he says. “I had a serious injury a couple of years ago. My top priority now is to take good care of my body so that I can keep playing. It’s not an easy thing to do, but I want to prove that it can be done and help this team win the trophy! You see no sign in him that shows he is ready to let his guard down. On the contrary, he even harbors a sense of crisis—precisely this team win the trophy.”

“I want to prove that it can be done and help the team win the trophy.”

“Whether the team wins or loses, Tabuse always thinks about how he could have done things differently. He always feels that there are still things that he cannot do well. He is never satisfied with the way things are. He says that this mental attitude is something he picked up during his days in the NBA.

“In the NBA, the very best players were spending more time than anyone on the most routine training and practices. And I’m talking about those star players. To catch up with them, you have to do everything you can, and you have to approach basketball with a serious attitude. Most of the time, though, you can’t do things the way did them in practice. Still, you have to keep working at it without giving up. Because that is the only way to success.”

The Road from the National Team to the NBA

As a former NBA player, and also given his age, Tabuse finds that the role he is expected to play has changed over the years. In this year’s Asian qualifier for the Rio Olympic Games, he returned to play for the national team.

“I was also invited to play for the national team 10 years ago, but back then I was too preoccupied getting ready for my shot at the NBA. So I turned down the offer. If I had the same opportunity now, I think I would do both. I think there are actually more things you need to do in order to win the trophy. A team that wins the championship has the strength to constantly keep doing the ‘simple’ things, even in the toughest times. The big challenge is making sure everyone on the team understands the importance of a single shot, a single rebound, and plays each game never forgetting this single moment.”

Whether the team wins or loses, Tabuse always thinks about how he could have done things differently. He always feels that there are still things that he cannot do well. He is never satisfied with the way things are. He says that this mental attitude is something he picked up during his days in the NBA.

“In the NBA, the very best players were spending more time than anyone on the most routine training and practices. And I’m talking about those star players. To catch up with them, you have to do everything you can, and you have to approach basketball with a serious attitude. Most of the time, though, you can’t do things the way did them in practice. Still, you have to keep working at it without giving up. Because that is the only way to success.”
First U.S. Aerostructures Assembly Line to be Established

Kawasaki will establish an assembly line for the cargo doors of Boeing’s state-of-the-art commercial airplane, the 777X, at Kawasaki Motors Manufacturing Corp., U.S.A. (KMM) in Lincoln, Nebraska. This is the first time for Kawasaki to establish an aerostructure production line in the U.S. The necessary equipment is scheduled for installation in the work area of about 2,800 square meters in the existing building prior to March 2017, so that the factory can start operation from May 2017. The 777X is the newest member of Boeing’s bestselling 777 family, the market-leading twin-engine long-range passenger airplane. Production is set to begin in 2017, with the first delivery targeted for 2020.

Kawasaki is engaging in the development and manufacturing of forward and mid fuselage panels, main landing gear wells, pressure bulkheads and cargo doors for the 777X. For the assembly work of the cargo door at the Lincoln factory, Kawasaki will use an automatic riveter and a painting robot developed in-house to enhance the automation and speed of production and ensure high quality, thereby increasing the efficiency in production.

The Lincoln factory began its operation in 1994, as a factory of Kawasaki Motors Corp., U.S.A. (and thereafter came under the control of KMM in 1995, when KMM was founded). The factory currently produces, among others, all-terrain vehicles, the Jet Ski® personal watercraft and railway vehicles. The factory has introduced the Kawasaki Production Systems (KPS)*1, Kawasaki’s internal production systems developed in-house to enhance the automation and speed of production and ensure high quality, thereby increasing the efficiency in production.

Medicaroid Corporation’s U.S. Subsidiary Commences Operations in Silicon Valley

Medicaroid Corporation, a joint venture between Kawasaki and Syneon Corporation, has established a subsidiary called MEDICAROID INC. in San Jose, U.S.A. MEDICAROID INC., which commenced operations in January 2016, will cooperate with Medicaroid in medical robot technology development, marketing activities and regulatory affairs for approval by the U.S. Food and Drug Administration (FDA), with the aim of expanding business going forward.

The scope of application robotic-assisted surgery, which was first introduced in the 1990s in the United States, is expanding rapidly as a type of minimally-invasive treatment, as various instances of clinical research and studies have shown evidence of its safety and efficacy in Japan, medical robots were approved as authorized medical devices in 2009 and have begun to be applied in surgical treatment for prostate cancer and other diseases.

In the United States, it is the world’s largest market for medical robots, accounting for approximately half of the total. The region around the Bay Area of San Jose, known as Silicon Valley, is a leading area for medical robot technology, being home to distinguished if companies, universities, medical institutes and medical robot companies.

Through MEDICAROID, INC.’s operation in this leading-edge environment, Medicaroid will develop the U.S. market for made-in-Japan medical robots utilizing the R&D and manufacturing capabilities of Kawasaki and Syneon, thereby contributing to the advancement of medicine.

Medicaroid’s subsidiary, MEDICAROID INC., has established a subsidiary called MEDICAROID INC. in San Jose, U.S.A. to develop medical robots for use in the United States.

Kawasaki will establish an assembly line for the cargo doors of Boeing’s state-of-the-art commercial airplane, the 777X, at Kawasaki Motors Manufacturing Corp., U.S.A. (KMM) in Lincoln, Nebraska. This is the first time for Kawasaki to establish an aerostructure production line in the U.S. The necessary equipment is scheduled for installation in the work area of about 2,800 square meters in the existing building prior to March 2017, so that the factory can start operation from May 2017.

Medicaroid Corporation, a joint venture between Kawasaki and Syneon Corporation, has established a subsidiary called MEDICAROID INC. in San Jose, U.S.A. MEDICAROID INC., which commenced operations in January 2016, will cooperate with Medicaroid in medical robot technology development, marketing activities and regulatory affairs for approval by the U.S. Food and Drug Administration (FDA), with the aim of expanding business going forward.

The scope of application robotic-assisted surgery, which was first introduced in the 1990s in the United States, is expanding rapidly as a type of minimally-invasive treatment, as various instances of clinical research and studies have shown evidence of its safety and efficacy in Japan, medical robots were approved as authorized medical devices in 2009 and have begun to be applied in surgical treatment for prostate cancer and other diseases.

In the United States, it is the world’s largest market for medical robots, accounting for approximately half of the total. The region around the Bay Area of San Jose, known as Silicon Valley, is a leading area for medical robot technology, being home to distinguished if companies, universities, medical institutes and medical robot companies.

Through MEDICAROID, INC.’s operation in this leading-edge environment, Medicaroid will develop the U.S. market for made-in-Japan medical robots utilizing the R&D and manufacturing capabilities of Kawasaki and Syneon, thereby contributing to the advancement of medicine.

Kawasaki has signed an agreement for a joint research program with Heriot-Watt University, U.K. for the development of algorithms for autonomous underwater vehicles (AUV) which will be utilized in offshore oil & gas fields. The project has already started in September 2015 and will continue for four years.

Kawasaki has been developing state-of-the-art underwater technologies, and employing specialists know-how, it is now developing leading key technologies for AUV operation. The offshore oil & gas industry is targeted as the initial market, particularly to address the demand for maintenance work on subsea pipelines laid on the seabed.

Through this joint research program, Kawasaki and Heriot-Watt University will develop, test and verify algorithms for position specification of target objects so that an AUV can autonomously locate and track pipelines underwater. Specifically, an AUV equipped with these algorithms is expected to track along a subsea pipeline at close range, including buried and invisible sections, using data from multiple sensors.

Kawasaki’s partner, the Ocean Systems Laboratory*, Heriot-Watt University, is well-known as a leading organization for research and development of new technologies in the offshore field, and it has expertise in control and autonomy of underwater vehicles for both offshore oil & gas and renewable-energy applications.

The know-how of Heriot-Watt University to develop tracking algorithms will be backed up with Kawasaki’s abundant on-site experience at offshore fields and technologies for manufacturing the vehicles, as well as programming the control method for auto-docking.

Through these technologies, Kawasaki will make progress in the research and development of leading-edge AUVs.

This joint research program will continue until August 2019, after which Kawasaki will build a demonstration model of an AUV incorporating the above algorithms. The AUV will be used to carry out final verification tests in a real subsea environment in the North Sea or elsewhere in 2020, with the aim of bringing a production model to the market in due course.

* The Ocean Systems Laboratory is a key laboratory within the Edinburgh Centre for Robotics, which is a CSBMA joint venture between Heriot-Watt University and the University of Edinburgh, supported by EPSRC (The Engineering and Physical Sciences Research Council), Industry and the Universities. It is a multi-disciplinary science and engineering research laboratory that innovates, applies and teaches world-class advances in autonomous systems, sensor modelling/processing, and underwater acoustic system theory/design for offshore, marine sciences, renewable energy, and security applications.

Kawasaki will build a demonstration model of an AUV incorporating the above algorithms. The AUV will be used to carry out final verification tests in a real subsea environment in the North Sea or elsewhere in 2020, with the aim of bringing a production model to the market in due course.

Joint Research for Development of Algorithms for Autonomous Underwater Vehicles

Kawasaki will build a demonstration model of an AUV incorporating the above algorithms. The AUV will be used to carry out final verification tests in a real subsea environment in the North Sea or elsewhere in 2020, with the aim of bringing a production model to the market in due course.

The Top 100 Global Innovators list is compiled by the global information services firm Thomson Reuters Corporation. Based on their patent data, the company selects 100 innovative corporations and institutions through analysis of each candidate’s intellectual properties and patent-related activities. The Top 100 Global Innovators list was first released in 2011, and 2015 marked its fifth publication.

This year’s top innovators were chosen based on four selection criteria overall patent volume, patent grant success rate (ratio of patents approved to patent applications submitted), global reach of the portfolio, and patent influence as evidenced by citations. Kawasaki was selected due in large part to its high marks in the patent grant success rate and global reach of the portfolio categories.

Joji Iki, Senior Executive Vice President (left) and Yoshiko Tanaka, Vice President, Japan Sales, IPS & Science, Thomson Reuters (right).

The Top 100 Global Innovators list is compiled by the global information services firm Thomson Reuters Corporation. Based on their patent data, the company selects 100 innovative corporations and institutions through analysis of each candidate’s intellectual properties and patent-related activities. The Top 100 Global Innovators list was first released in 2011, and 2015 marked its fifth publication.

This year’s top innovators were chosen based on four selection criteria overall patent volume, patent grant success rate (ratio of patents approved to patent applications submitted), global reach of the portfolio, and patent influence as evidenced by citations. Kawasaki was selected due in large part to its high marks in the patent grant success rate and global reach of the portfolio categories.
The Kawasaki Group creates new value by channeling its engineering prowess into various fields, including land, sea, and air transportation systems, energy and environment, and industrial equipment, and also by pursuing synergy that goes beyond the boundaries of these respective fields. Kawasaki strives to maintain harmony with the global environment as it works toward its vision of a better future.

Kawasaki, working as one for the good of the planet

Kawasaki Heavy Industries, Ltd.

Special Feature
Kawasaki's Century-Old Business Takes on New Fields

Spring 2016
No. 107
Kawasaki Heavy Industries Quarterly Newsletter