WHO CAN MEET THE NEEDS?
JAPAN WILL OFFER THE SOLUTION!

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Supported by
THE NIPPON FOUNDATION
To help makers develop and realise new products, Japan Ship Machinery and Equipment Association has received support from the Nippon Foundation and is now providing business assistance to them.
Fuel prices are increasing and the cost burden is high.

ISSUE 1

Japanese Eco ships cover all ship types and have already realised the highest levels of fuel efficiency in the world.

SOLUTION

Fuel efficiency is not a new topic for Japanese shipyards. For the last 40 years a lot of technology resources have been placed into fuel efficiency research and development. The Eco ships now on offer from Japanese shipyards have advanced hull forms that contribute to propulsion performance. These hull forms have been matched with fuel efficient main engines and other machinery as well as independently developed additional fuel efficient equipment which is all supported by technology.

Sayaringo STaGE LNG carrier

Mitsubishi Shipbuilding’s next generation LNG carrier (Sayaringo STaGE) is a vessel highly acclaimed for its improved Mess-type spherical cargo tanks and outstanding reliability. The adoption of the apple-shaped tanks in addition to a continuous cover has enabled an increase in LNG carrying capacity, and hybrid propulsion system combining a steam turbine and engine that can be fired by gas has enhanced overall fuel efficiency significantly.

20,000TEU Type Container Carrier “MOL Truth”

It is high fuel efficiency that is a marketing weapon of Japanese shipyards, as a size of container carriers grows larger. The “MOL Truth” 20,000TEU Container Carrier built by Imabari shipbuilding has adopted the cutting-edge technology such as low friction coatings, a highly efficient propeller and engine plant, a highly optimised hullform which has achieved a 30% CO2 emission reduction per container transported, much less than that of former design of 16,000TEU.

Sunflower Kirishima

The Japan Marine United built ferry combines fuel efficiency technologies such as a newly developed highly optimised hull form and contrarotating propellers to achieve an advanced fuel efficiency performance. It is driven by a hybrid propulsion system using the main engine or electric motors. It has achieved a high performance both in fuel efficiency during operation and manuevering in harbours.

TRANS HARMONY 1

The Nisshin Zosen built new type car carrier has through the use of all types of low energy measures such as low wind resistance hull form and low energy additional equipment (STEP) and other equipment reduced fuel consumption by around 15%. For each car transported CO2 emissions have been reduced by 12% compared to existing ships. In addition, a liftable deck on two decks of the vessel has increased the ships capability to carry high and heavy vehicles. As safety measures for crew, a crew member identification system that can show whereabouts of crew in the ship and an infrared video camera system that can monitor in the dark have been installed.

Waste heat recovery system

In Japan there is technology that recovers and reuses the waste heat from the engine room to improve fuel efficiency. For example, three companies—Kobe Steel, Murak and Asahi Shipping—have jointly developed a binary power cycle generation system for ships that uses the waste heat emitted from the engine's turbocharger to generate electric power for use as the ship's auxiliary power. Mitsubishi Heavy Industries Marine Machinery & Equipment (MHI-MME) has also organic rankine cycle power generation system (ORC) in its variety of energy saving product portfolio. Because of ORC, MHI-MME keeps on improving a technology of Waste Heat Recovery System (WHRS) and well proven technology using twin turbines combination system comprising of exhaust gas turbine and steam turbine is available in the market and it has obtained very good reputation by its high performance.
ISSUE 2
Building a new replacement vessel is difficult so there is a need to increase the fuel efficiency of existing ships.

The development of low energy technology is a specialty of Japan. Japan’s ship machinery manufacturers are providing fuel consumption improvement technology to all vessels whatever the size or type. In particular low energy propulsion efficiency machinery and low friction anti-fouling coatings can be simply applied after a ship has entered into service contributing to an improvement in the operating efficiency of the existing fleet.

CFRP Propeller

Hakataima Propeller was the first company in the world to develop a CFRP propeller for standard merchant vessels.

It uses stronger materials in the blade than has been used conventionally before, resulting in high efficiency and low vibration. CFRP propellers bring high efficiency and low vibration. It has also achieved an advanced propeller in terms of quietness; they are also advanced in terms of quietness.

Controllable Pitch Propeller

Kamome Propeller has achieved world leading sales of controllable pitch propellers. By adjusting the blade angle the ship speed can be simply controlled across the full range of speed from top to dead slow including stopping and reversing.

In combination with the original central device that took the propeller off-design performance into consideration, it is possible to restrain variation of the main engine power due to external changes or change of load condition to improve the maneuverability, safety and economy of ship operations.

ISSUE 3
Ships which show good fuel efficiency during sea trials can see speed significantly reduced during actual operations.

In Japan there is a wide variety of technology to improve the efficiency of ships in operation. No matter what the size or type of vessel there is an answer.

Super(Ultra)-low-friction anti-fouling paint

Japanese marine paint manufacturers are aiming at improving ship propotion by developing paints that reduce frictional resistance and also protect ship's bottom from biofouling by marine creatures.

They are also considering the marine environment by bringing up products which meet environmental performance standards.

Recently, ChissoKo Marine Paints has started to introduce SEATEO NEO CP PREMIUM, curvaceous-side free and fuel saving anti-fouling, Nippon Marine Paint. Coatings is adding to the product line, i.e. a biofoul-free SPC anti-fouling - Avaneras and super-low friction anti-fouling paints - Avaneras Sea & the new UF Series.

OCTAVIA

A joint industry project called OCTAVIA has been established for developing a method of accurately evaluating the performance of ships in actual sea conditions.

Involves 25 Japanese shipping, shipbuilding, marine equipment companies and the related organizations.

By establishing an objective index for ship performance, it hopes to realize more efficient worldwide transportation and lead to reduction of load on the global environment.

BOW

Japanese shipbuilders are taking into consideration actual sea conditions to develop their own original bow shapes on newbuilding ships.

Japanese Marine United's LEADSO-Bow has sharp shape at the water line section of the bow and which reduces resistance from waves and also reduces fuel consumption when encountering heavy wave conditions.

WIND

Japan has been looking at the problem of wind resistance from an early stage. RUGA AOC, the first vessel in Mitsui O.S.K. Lines’ Riser series of next generation carrier, has a spherical shape bow that reduces wind resistance. Compared to existing carrier it is expected to reduce CO2 emissions by around 2%.

EEDI Weather

The Energy Efficiency Design Index (EEDI) is an index based on flat calm sea conditions. On the other hand, EEDI Weather is an index which assesses the influence of wave and wind in actual sea conditions on the fuel consumption of ships.

In May 2017, the pre-verification certificate of EEDI Weather was issued to Namura Shipbuilding in collaboration with National Institute of Maritime Research Institute for the VLCC by ClassNK as world’s first VLCC.
**ISSUE 4**
The IMO has agreed a strategy to reduce greenhouse gases (GHG). What measures are available to reach the GHG reduction targets?

In Japan, there are many projects progressing to find new methods to power ships such as wind power, hydrogen, bio technology and other solutions.

**SOLUTION**
Japan is taking a lead in the research and development of alternative next generation technologies to reduce GHG.

**ISSUE 5**
The IMO’s global regulation of sulphur oxide (SOX) emissions begins in January 2020. Which compliance method should be taken?

Japanese ship machinery manufacturers have faced an early stage development technology to meet every type of new regulation and proposing solutions that meet the different needs of each customer. By constantly upgrading existing products and developing new technology each year new technology and products are being launched.

**SOLUTION**
There are many options to controlling SOX emissions, and Japan has a full line up of the alternatives.

**Hydrogen fuel**
In fiscal 2017, as part of a project received from the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) to draw up the draft guidelines for safety of hydrogen fuel-cell powered boats, Yanmar, the National Maritime Research Institute (NMRI) and the Japanese Ship Technology Research Association (JSTRA) conducted tests on an actual hydrogen fuel cell ship. These tests were carried out on the NMRI-managed test ship which was fitted with a Yanmar built fuel cell system and a lithium-ion battery system made by BSMAC Corporation. Yanmar is continuing the research and development aimed at realizing the hydrogen fuel cell powered ship of the future.

**Battery Ship**
Battery power is known as most promising solution for GHG reduction on short distance voyages. Osima Shipbuilding is currently building a small passenger ship for 50 person powered by Lithium-ion Batteries. The project also includes the plan to fit the ship with an automated navigation system and, in the future, to establish the technology for autonomous navigation.

**Bio Fuel**
As biofuel is mainly made up from plants it is effective as a carbon neutral alternative fuel which not only reduces carbon dioxide (CO2) emissions, but also sulphur oxide emissions and it is emerging as a promising candidate to become a marine fuel. Yanmar adapted a marine engine for the use of biofuel and, as part of research into a hydrogen fuel cell, confirmed that refined palm oil can be used as a marine fuel.

**Japan’s SOX scrubber systems**
Japan has SOX scrubber technology that is recognized around the world. For example, Full Electric’s SOX scrubber has for the first time introduced cyclone technology into the internal construction of a scrubber. It is the world’s smallest scrubber and with no movable parts, pressure loss is very low. Also Mitsubishi Kaseki Kaisha’s first SOX scrubber system is the first to receive recognition as a domestic product from the Republic of Panama, a major ship registry.

**Onboard sulfur-in-oil analyzer**
Nippon Yusen Kabushiki Kaisha (NYK) and Nippon Yuka Kogyo, a NYK Group company, have teamed with HORIBA, to develop a new portable sulfur-in-oil analyzer that can detect the presence of sulfur in fuel oil onboard a vessel. The new device will be utilized to check the compliance with the IMO fuel sulfur regulation, as well as to determine the best timing to change fuel and adhere to regulations which contribute toward the reduction of fuel consumption, through the analysis of data from various vessels.

**Rectangular Scrubber**
Mitsubishi Shipbuilding and Mitsubishi Hitachi Power Systems (MHPS) have jointly developed a DE-SCR type (Rectangular shape) SOX scrubber intended for large-size vessels. The product is developed by combining MHPS’ comprehensive exhaust gas treatment technologies, culminated through its exhaust gas desulfurization systems for thermal power plants, with Mitsubishi Shipbuilding’s marine engineering expertise. The application of a rectangular shape realizes superior space saving essential for onboard installations. The two companies have also developed the world first tunnel which integrates SOX scrubber. ACTIVE TUNNEL, to enable best space efficiency and shortest installation work period.

**MGO mono-fuel engine**
Japan Engine Corporation (JENG) is developing a new marine engine “JEC6S4U” which burns only marine gas oil (MGO). This next-generation engine is fully compliant with SOX emission regulation 2020 and IMO’s NOx Tier III regulation, and furthermore, realizing remarkable low fuel oil consumption which could contribute to the upcoming strengthened newbuilding efficiency standards of the Energy Efficiency Design Index (EEDI). And owing to the stable quality of MGO, the engine maintenance cost can be saved.

**Retrofitting**
Demand is increasing for the retrofitting of ships with SOX Scrubbers and Ballast Water Treatment Systems. Senwa Dock is one of the first shipyards in the world to create and successfully employ a process for retrofitting using 3D laser scanners so that the engineering and construction work can be performed quickly.
There is increasing momentum towards the use of LNG as marine fuel. What is the current state of research and development for LNG fuelled ships?

Japan has committed resources to the development of ships, engines and equipment to utilise LNG as fuel. There are many examples of LNG powered dual fuel (DF) engines in operation with high level of reliability and maturity. As part of the drive towards the development of ships that are environmentally friendly, a variety of research and development is taking place to encourage the wider use of LNG as marine fuel.

Gas-fuelled low-speed four-stroke engine

In 2018, HANSHIN Diesel completed the world’s first gas-fuelled low-speed four-stroke engine (G20), while maintaining the same basic construction of the current diesel engines. The combustion chamber has been modified for gas. G20 meets the requirements of the IMO’s NOx Tier III emissions standards and has achieved higher fuel efficiency than current diesel engines.

Dual Fuel Engine

Almost all marine engine makers in Japan have LNG powered dual fuel engines in their product line. Diesel United played a central role in the development of the world’s first low pressure lean premixed combustion type II six-stroke engine (LGLS). Among the medium-speed engine manufacturers, Nippon Power Systems created the world’s first dual-fuel engine that can be directly connected to a fixed pitch propeller (FPS); Yanmar and Hino Marine Diesel have also independently created their own dual fuel engines and have a full line-up of products which are environmentally friendly. From now on, each manufacturer will continue their strategy of developing highly reliable and environmentally friendly products.

FGSS

Sanyo Shipbuilding and Sumitomo Seika have jointly developed the LNG fuel supply system (Fuel Gas Supply System FGSS) and they have already received orders for low pressure type FGSS used with 6-cylinder dual fuel engines. The system is comprised of vaporizer, buffer tank, and a double skin vacuum insulation type LNG containment system which has superior insulation performance. Simple construction is one of the specialties of this design. No pump is used but by simple adjustment of the pressure, LNG is supplied to the vaporizer.

LNG Fuelled Bulker

Nippon Yuzen Kabori Kasha (NYK) and Oshima Shipbuilding are jointly developing designs for a post panamax LNG fuelled Bulker. A new feature of the design is that the LNG tank is positioned behind the accommodation area to shift the impact on the cargo space to a minimum. The LNG tank and associated equipment are built as a unit on land for quick installation when the vessel is in dock, cutting the usual LNG conversion time by around 20%.
In Japan there are various trials underway with the aim of utilising ship Internet of Technology (IoT) data. ClassNK’s wholly owned subsidiary Ship Data Center (ShipDC) started working toward the establishment of an industry open platform of data collected from ships - known as the Internet of Ships Open Platform (IoS-OP) - by setting up a consortium of IoS-OP users in May 2018. Through the management of IoS-OP, ShipDC is aiming to realise the flow of data throughout the maritime industry.

The creation of a ship data open platform with practical rules that are developed with specific details is the world’s first. The initiative that the Japanese maritime cluster put together in developing a method of sharing the industrial data is drawing a lot of attention from other industries.

**Ship data starts to be used**

ClassNK and ShipDC has worked on Data

<table>
<thead>
<tr>
<th>2016</th>
<th>2017</th>
<th>2018</th>
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<tbody>
<tr>
<td>Practical situations with regulations</td>
<td>Technical trials</td>
<td>Full-scale operation of the IoS-OP platform</td>
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</tbody>
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ShipDC is dividing up the work at both the upstream and downstream levels including areas such as the creation of data, collection and delivery of data, data storage and its use by allowing each company to participate in its own area of specialisation. It is also forming a consortium consisting of users of IoS-OP to manage the structure to provide permanent, fair and reliable independent services.

As of October 2018, around 50 shipping, shipbuilding, ship machinery and ICT companies have participated in the IoS-OP consortium and are promoting the use of the data platform.

When the project first began, the plan was to collect data from 300 ships in 2018 and 500 ships by 2022. Now the aim is to expand the consortium to 100 companies and five service providers by 2022. Participation in IoS-OP is not restricted only to Japanese companies and participants are being invited from across the world.

**Three areas of activity aimed at data usage**

The IoS-OP has established three working groups involving three key areas: Rule Making/Data Governance/Solutions and Business Development. Each working group has formed sub-working groups such as setting up a testbed, providing a place for business matching, and other measures to progress the use of industry data. Member companies participated in the working group of their choice.

The rule making/Data Governance working group is providing information on data laws, rules and guidelines and looking at the experiences of other industries. The Solutions working group is tackling areas such as preparing the ground for a Solution Service using IoS-OP, approaches to standardisation and a test bed management for the verification of interconnectivity of the solution and IoS-OP.

The Business Development working group is concentrating on the use of data, looking at the needs of the market, forming a matching place for early stage technology, and undertaking pilots and other activities to promote the work outside Japan and to other industries.

**Outline of IoS-OP**

IoS-OP will support maritime cluster for their innovation, digitisation and transformation and next generation business.

**PU Platform User**
- Shipowner
- Operator
- Shipyard

**PP Platform Provider**
- Take company of ships operator
- Solution provider of shipyard data collection

**SHIP DC ShipDC**
- Provide
- Ship data
- Data set
- Data validation
- Data exchange
- Standard
- Based on
- KCSA

**SP Solution Provider**
- Data analytics or visualised service
- Solution for shipyard using KCSA/ACS

**SU Solution User**
- Shipowner/Operator/Shipowner/Ship

**Outline of IoS-OP**

IoS-OP will support maritime cluster for their innovation, digitisation and transformation and next generation business.

**IoS-OP**
- For shared and independent management of IoS-OP
- Advisory members in May 2018

**IoS-OP Common Rule**
- For data distribution
- For data storage

**ShipDC**
- DB Data Buyer
- Shipyard
- Maritime data
- Weather company
- Insurance

**International standards for ship data collection**

The Japan Ship Machinery and Equipment Association’s newly formed Smart Ship Application Platform 2 Project (SSAP2) is attempting together with the IoS-OP, to create an international standard which will be an essential requirement for the use of IoT data.

In 2019 Japan proposed to the ISO a standard for the onboard ship data server (BODIS) and a standard for ship machinery and data equipment (SCMDE). In October 2018 these two standards became established and published by ISO.

**Rules for IoS-OP**

IoS-OP provides common and individual rules for each participant in order to distribute IoT data among stakeholders effectively.

**IoS-OP test bed starts operations**

In October 2018, ShipDC began operating an IoS-OP test bed at the ClassNK Information Center in Chiba prefecture, Japan, as a service to the member companies.

By utilising IoS-OP, members can make technological verifications on the sensors and internal data collection systems, prototypes before their installations onboard.

There are issues arising such as the restriction of adjustments between related parties, the handling over of the vessel and the operating schedules when onboard data is collected and sent through satellite communication systems and when the transmission tests are carried out.

For this reason, a platform provider data collection system and a replica of the onboard environment have been set up inside the ClassNK Information Center. Outside, this is set up a high experiment antenna that can send information to the blockchain-based ShipDC data centre.

ShipDC has allowed member companies to freely use the equipment and test the connectivity of a variety of land-based data collection systems and onboard ship applications systems. The IoS-OP test bed is offering the opportunity to test the ship to shore satellite broadband and data transmission. From these tests, it is expected that the overall workflow and the frequency of onboard tests can be reduced. Further, solution service providers can also introduce their services through a demonstration on the test bed.

The IoS-OP test bed involves Inmarsat, JRC and Sky Perfect JSAT in providing communication systems, BIMAC Corporation, JISAC, Terawave Electric, Nippon Telegraph and Telephone, Furuno Electric, Alabama Laboratories (Watts Zosen) and MTN in providing onboard data collection systems and ClassNK in providing facilities and equipment. Member companies can use the test bed, including satellite communications systems, at no charge.

**Outline of IoS-OP**

IoS-OP will support maritime cluster for their innovation, digitisation and transformation and next generation business.
**ISSUE 7**

The ballast water management convention has entered into force and the planned installation off ballast water treatment systems is now required.

**SOLUTION**

Japan has developed various types of ballast water treatment systems and can offer total support including retrofitting vessels.

In Japan, it is possible to find a ballast water treatment system suitable for any ship type. The installation of ballast water treatment systems, especially for existing ships, is severely limited by space. But Japanese makers are meeting the customer's needs by developing compact and simple systems. Systems are also being developed to ensure that the equipment is in compliance with the regulation.

**JFE BallastAce**

The JFE Engineering developed JFE BallastAce is a chemical-based ballast water treatment system. In November 2018 it became the first Japanese equipment maker (and the 15th in the world) to have its product approved by the United States Coast Guard (USCG). It is a system in which simplicity is its special feature. In the system, ballast water is treated with chemicals after it has been passed through a filter.

**Kurita BWMS**

Kurita Water Industries is increasing its efforts to market its filter-free ballast water treatment system (KURITA BWMS) outside Japan. As the development of the product is mainly aimed at the market for existing ships, it has a simple construction in which the configuration can be easily adjusted.

**HK**

MURAI's ballast water treatment system HK uses its own independently developed filter in combination with UV. A compact version is now being marketed to broaden the ships types that can use the system. For the retrofit market, MURAI is offering the 3D measurements performed by its own engineers and a supervision support system.

**Satake viable organism analyzer**

Ballast Eye / viable organism sampler

New portable viable organism analyzer was released in January 2019. Fast 1-minute test (30-15 minute sample preparation required) determines the number of both 20μm and 10μm surviving organisms. It utilizes Pulse Counting IKA method to detect both zooplankton and phytoplankton.

Viable organism sampler concentrates 1 cubic meter of ballast water into 100 ml to be used along with Ballast Eye. This compact portable sample concentrator does not require power source and quickly connects to the existing line. Sales are planned from April 2019.

**ISSUE 8**

Support provided to ships after they enter into service is often a concern. Shipowners want to entrust ships to a repair yard they can trust.

**SOLUTION**

Japanese ship repair yards have a good reputation for work quality and punctual delivery and a wealth of maintenance know how.

Japan does not only have newbuilding yards it also has many ship repair yards. There are also some newbuilding yards with specialist divisions or subsidiaries that offer future support for the safe and continuous vessel operation of newbuildings. There are many ship repair yards and specialist factories located throughout the country involved in inspection, conversion, retrofit and various other services providing a kind of “Dr Ship” support service for needs of shipowners.
The shortage of seafarers is becoming serious and there is a need to reduce incidents involving human error. Is there a way to reduce seafarer’s workload and achieve safer navigation?

In Japan, using data collected from ships, there is technology available that can make it possible to understand the situation onboard in real time and discover irregularities at an early stage and to prevent the development of problems. The use of digital technology not only improves safety but also improves the efficiency of seafarers’ work and can also be used for educational purposes.

**Advanced Safety Management System**

Japanese marine engine makers are progressing with the introduction of advanced support systems for ship management.

Advanced support systems for ship management allow the condition of the propulsion engine and generator to be monitored and diagnosed remotely from shore. The system makes possible advanced engine safety management, optimal maintenance and labour saving, contributing toward ship safety.

Mitsui SSE Machinery, Diesel Urd Ltd and others are providing services by using ClassNK’s Ship Maintenance Management System (ClassNK CMAXS) to monitor the condition of the main engine. Yamarl Engineering, one of Yamar’s subsidiaries, is offering the technical support (SHIP-SUPPORT®) by using engine data.

Hansei Diesel Works also has its own engine monitoring and ship support system (HANASYS EXPERT) installed on many ships.

**SOPass**

Kawasaki Heavy Industries’ ship operation and performance analysis support system (SOPass) provides optimisation functions of ship’s operation by analysing various data obtained from ship and weather forecast data. These functions include weather routing, performance analysis with forecast, and maintenance management. In addition, specialised to LNG carriers, it manages the bulk gas during transportation with proposing the route that minimises fuel consumption and optimised load amount.

**Kirari NINJA**

MTI and Da stron jointly developed a device (Kirari NINJA) to automatically photograph the interior of a vessel’s engines’ combustion chamber. By utilizing the product, crew members don’t need to enter the inside of the engine to inspect the combustion chamber, so that their workload is significantly reduced. Nippon Yusen Kabushiki Kaisha (NYK) and MTI have also developed original software that uses photo data from Kirari NINJA to prevent accidents by quickly determining the cause of failures at an early stage.

**INFINITY Training**

URCS is developing an education service for mariners that utilizes ‘Hololens’, a mixed reality (MR) headset which assimilates reality with virtual space. The company aims to spread INFINITY Training by using the Microsoft Hololens coupled with a translation function making remote training a solution that mariners can receive without the concern for location, time or language.

**Remote Boiler Burner Maintenance System**

Sunrama is developing an auxiliary boiler binary remote maintenance system (Sunrama Smart Support System) to be used for trouble shooting and providing optimal operational support, logging data is sent through the onboard server which is analysed in real time at a land-based office to minimise the risk of an accident and to find early solutions to the development of trouble.

**Remote Monitoring System for Marine Pumps**

In cooperation with Nippon Yusen Kabushiki Kaisha (NYK), MTI and Eagle Industry, Nanwa Pump Manufacturing is conducting research of diagnostic technology permitting remote monitoring system of marine pumps. The system aims at improvement of safe operation and reducing maintenance costs of marine pumps by shifting maintenance based on operating hours to the maintenance as required the actual state of the components.

**Onboard**

Auxiliary machine

Data accumulation

Diagnosis

**Training**

Audit support

Onboard observation centre

Ship structure communication

**Photo**

Hansei Diesel Works, Inc.

Photo: Kawasaki Heavy Industries, Inc.

Photo: MET Co., Ltd.
Japan looks toward automated shipping

The primary theme of research and development in the maritime field is the autonomous ship. Japan has set 2025 as the target year to develop the autonomous ship and to achieve this is carrying out a variety of projects at an industry level.

Around 80% of maritime casualties are caused by human error. Through ship automation and independent operation, it will become possible to greatly reduce this type of human error and it is also expected to contribute to reducing maritime accidents. In addition, it is thought that automation and independent operation will also contribute to reducing the burden on seafarers and is expected to change the character of maritime transportation. The International Maritime Organization (IMO) is exploring the development of regulations toward the realization of ship automation.

To realize the autonomous ship, it will be necessary to develop two areas in tandem, that is, research and development projects for ships utilizing the advanced technology such as IoT technology and big data analysis alongside the creating an environment for the realization of autonomous ship such as development of safety criteria. As for research and development for several years, Japanese shipping and shipbuilding companies have been carrying out joint research utilizing the advanced technology such as IoT technology and big data analysis. Since 2018 the Ministry of Land Infrastructure, Transport and Tourism (MLIT) began the Maritime Productivity Revolution Programme, known as i-Shipping, and through the project has been promoting research and development on digitization in maritime sector.

Also the MLIT has been developing the environment to realize the autonomous ship including the safety regulations through trial projects which began in 2018. At first it is testing the three core areas of the autonomous ship which are automated steering, remote control and automated berthing functions.

The trial project of automated steering is being handled by Osaka Shipbuilding and Marine Engineering. To secure the safety of automated steering it is important to ensure the reliable operation of collision avoidance and grounding prevention functions. Through the simulation of automated steering the project conducts the collection of necessary data for development of generic method of safety verification on automated steering logic. Eventually trial through actual ships in operation will take place and it is planned the information will be used in the creation of standards and other areas. The verification of the remote operation of ship is being carried out by Nippon Yusen Kaisha (NYK) group company MLI in a group of 16 companies. A computer will collect, integrate, and analyze information around the ship to create an action plan, and after the approval of operators at remote locations on board, take action in accordance with the plan. Through the data collection, simulation and verification, this demonstration aims to create a system that will bring this action plan into a real situation.

The knowledge received from this demonstration can be used in studies into securing the safety of the system such as determining the required onboard functions, the data that should be sent from ship to shore and the safety requirements for data transmission.

Verification through simulation is the first step but from now on it is verification tests on real vessels in operation is planned. Tests on automated berthing operations are being undertaken by four companies including Mitsu F&S shipbuilding and Mitsui O.S.K. Lines. Berthing is one of the most difficult aspects of ship operation and involves automation and autonomous. The verification project involves discovering the technical issues by creating a virtual offshore quay where a real vessel will undertake automated berthing.

Firstly the Tokyo Maritime University vessel Shijii Matuzi will carry out the first tests but in the future it is foreseen a large scale ship and a real quay will be used. The results will be used to make standards and other related measures.

Also, at the private company level, members of the Japanese maritime cluster have established a research platform aimed at realizing the autonomous ship. In 2017 the Japan Ship Technology Research Association (JASTRA) through the research platform, set up the Automated Seaborne Transportation System Research Committee involving the big three Japanese shipping companies, coastal operators, cruise ship operators, shipbuilders, ship machinery manufacturers, universities, research institutes, a classification society, insurance and communications companies. Through these various institutions this research committee is taking a comprehensive view in areas including studying business models and technical concepts for automated vessels.

Since 2018, with the support of the Nippon Foundation, as part of a study into developing a business model for automated shipping, it researched an automated seaborne transportation system with an unmanned vessel and studied the efficiency of unmanned vessels and possible routes, cargoes and ship types.

Around the world this vision of an unmanned ship is being established and research and development extending beyond the frame of individual companies is progressing.

The Hal built vessel Kinpozan Matuzi was the world’s first autonomous ship. It had bridge control system allowing direct control of main engine room from the bridge and included a centralised supervisory and control system that intensively monitors and controls the engine room. Since then Japan has been taking the lead in developing automated technology.

By bringing together technology and knowledge held by different companies Japan is aiming to realise the important theme of ship automation.
ISSUE 10
Market demand for ship types and ship sizes are constantly changing.

Based on detailed market analysis Japanese shipyards are constantly supplying ships that meet with changes in seaborne trading conditions.

SOLUTION
There are issues that cannot be solved via infrastructures on land thus far such as in providing logistics services, power distribution and so forth.

ISSUE 11
Japan’s floating structures can provide a variety of solutions.

Logistics
Today, as offshore oil and gas development takes place at an increasing distance from land, *JDeeP Technology and Engineering Research Association provides a Logistics Hub System for passengers and for materials by placing a staging point between a base port and the offshore development fields. *JDeeP consists of all the loading players in the Japanese maritime cluster which are fully equipped with the design and construction experience relevant to the realization of this concept and other floating structures for various purposes such as a support platform for sub-sea equipment.

Water and Electricity
MODC’s FSRU™ (Floating Storage, Regasification, Water, and Power) is an originally designed multipurpose floating gas facility which not only provides LNG regasification but also gas electrical power generation and water desalination capability.

JMU’s Malaccamax VLCC
Japan Marine United developed the JMU Malaccamax type VLCC as the optimal ship design for the oil trade between the Middle East and Japan with the main consideration the size limits of Japanese domestic oil terminals. Using the latest analysis techniques it developed a low emission high efficiency hull form and applied Japan Marine United’s own energy saving Super Stream Duct, SURF-Bulb, AV-Flow to optimize the design and bring a significant reduction in fuel consumption.

63,000M.T. D/W Type Bulk Carrier
Imabari Shipbuilding has been a world leader in developing handymax bulk carriers over 60,000dwt. With the beam dimension of the conventional 50,000dwt bulk carrier not being changed and its high versatility maintained, a deadweight of the carrier has been steadily increased. The design of 61,000dwt has proven a big success and now orders more than 100 units. Imabari has further developed the design and currently builds the 63,000dwt bulk carrier. Its fuel consumption performance has been significantly improved and the design has received high praise in the market.

87,000-dwt Bulker "neo87bc"
Mitsui E&S Shipyards has developed a post panamax bulk carrier as a next generation Eco ship. The design has improved transportation efficiency and usability in the grain trades which do not transit the Panama Canal. Its shallow draft allows it to enter a wide range of ports and also has a wide range of trading options and can also operate in the coal trades. The environmental features and fuel efficiency of the design have also been strengthened and it can meet all the environmental regulations. The first ship will be delivered in 2020.

41,000-dwt Bulker
Sanyo Shipbuilding has developed a new concept 41,000dwt bulk carrier design based on a marketing survey of many of its customers. While being of double hull construction for cargo hold, it has achieved large cargo capacity of 40,000mt. The vessel is not only focusing on main dry bulk cargoes but also a wide variety of cargoes such as timber and steel products. The design’s beam has been widened and it has a shallower draft than conventional handymax bulk carriers increasing its usability and allowing it greater access to ports and routes. It has also achieved a top class fuel efficiency performance among handymax bulk carriers.

Electricty
An increase in demand for electricity is expected in developing countries. There are many islands where there are insufficient electrical power generation systems and there is a need for small scale rather than large scale power generation units. Large capacity diesel engine or gas turbine power generators situated on floating offshore structures could provide a solution to this problem. Such a system could also be used to provide electricity in developing countries while the land based power generators are being updated.

Mitsui E&S Group is utilizing the technology of its group companies in LNG carrier construction, power generation plant, gas engineering and floating offshore construction to offer an optimised LNG power generation barge. Kawasaki Heavy Industries has developed a highly efficient LNG floating power plant, for which two types of electrical power generation system (a gas engine power plant or a combined cycle power plant) can be selected. AI components concerning the electric power generation systems, LNG tanks and floating unit can utilize Kawasaki’s own technology.
In some countries the ageing of the coastal fleets is becoming a serious problem because there is no domestic shipbuilding capacity available.

Japanese shipyards are building ships specifically designed for the local conditions in each country including South East Asia. Patrol vessels and coastal vessels are also being supplied using Official Development Assistance (ODA) to strengthen cooperation in the marine industry.

**Patrol Vessel**

Sumitogawa Shipyard constructed two 15m Type Patrol Vessels for Sri Lanka Coast Guard on the basis of Japanese grant extended by Japan International Cooperation Agency (JICA). The Vessels are expected to contribute to maritime safety improvement in Sri Lanka by enhancing the ability to secure maritime safety and security.

**River Ferry**

Everyday around 30,000 people cross the river that dissect Myanmar's Yangon city. To replace the ageing fleet of ships that transit the river Kokang and shipbuilding is supplying three twin-engine twin-propulsion system ferries the Cherry-1, Cherry-2 and Cherry-3.

**Research Ship**

The fishing industry is an important export industry for the Kingdom of Morocco but in recent years the catch has become unstable and the long term management of the industry has become a major issue in the country. To upgrade the country's fishing research capability, Sumitomo SHIPBUILDING is building a state of the art offshore fisheries research vessel for the Morocco National Fisheries Research Centre, Toyota Tsusho Corporation is acting as main contractor and the vessel is scheduled to be delivered in 2021. The ship building finance has been arranged between the Japanese and Moroccan governments on a Japanese Yen loan basis.

**SOLUTION**

Japanese shipyards are exporting various types of coastal vessels including survey ships and patrol boats.

A shipowner wants to build attractive passenger ship good enough to be called a cruise ship.

**Silver Tiara**

The Nisaki Zosen built ferry Silver Tiara places importance on comfort and privacy and, as its name suggests, it shines like a jewel. There are a variety of rooms provided including rooms that can also be enjoyed by pets and special rooms for women with small children. The ship also has bow rolling in operation and a high manoeuvrability during berthing and unberthing.

**ISSUE 13**

There are many Japanese built ferries operating along the Japanese coastline. On top of energy efficiency and safety, these ships also address the passenger's needs and have rooms and internal styling that match the routes in which they sail.

**SOLUTION**

Japanese built ferries are Eco-ships that can offer voyages aimed at the customer.

**AZALEA**

The Mitsubishi shipbuilding built Azalea is a new design ferry offering comfortable travel. Compared to earlier designs, it has achieved both an increase in speed and a reduction in fuel consumption. The vessel has newly designed hull form, ”Proximity twin-screw system having shaft brackets” and the Mitsubishi Air Lubrication System (MALS) to achieve a 10% reduction in fuel consumption.