



Innovation Through Co-Creation: The NYK Group's Technologies



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“There Have Always Been Partners at Every Turning Point”

Takaya Soga

President of NYK

Nippon Yusen Kaisha (NYK), which marked the 140th anniversary of its founding in 2025, has acquired and refined new technologies through co-creation. From the construction of dedicated vessels in its early years to more recent initiatives such as autonomous navigation and decarbonization, the range of technological themes the company takes on has continued to expand. As these technologies become increasingly complex, it becomes essential to bring together knowledge with partners, including shipyards and marine equipment manufacturers. President Takaya Soga states, “There have always been partners at every technological turning point.”

A Living Spirit of Co-creation

— What do you think are the defining characteristics of the NYK Group’s technological development?

From an organizational perspective, the presence of MTI, the Monohakobi Technology Institute, within the Group is extremely significant. MTI serves as the core of R&D and also plays a leading role in industry-academia collaborative projects with institutions such as the University of Tokyo and the University of Osaka. It accurately anticipates the technological needs of the NYK Group, conducts fundamental research, and then works consistently from that foundation through to applied development. The existence of MTI is a powerful asset for us.

Another characteristic is that we have actual operational sites. We have vessels, warehouses, and other facilities within the company and Group where hypotheses can be tested. Personnel on the front lines, including seafarers, carefully assess whether new technologies are truly useful.

NYK has long placed importance on people and technology. We have a history of conducting various development initiatives through collaboration with partners. For example, we have worked together with domestic shipyards to build dedicated vessels such as large tankers, wood-chip carriers, and car carriers. When electronic navigational charts were introduced, we responded by collaborating with marine equipment manufacturers. There have always been partners at every technological turning point. In our current medium-term management plan, “Sail Green, Drive Transformations 2026 — A Passion for Planetary Wellbeing,” we use “co-creation” as a key concept, but in fact this is something we have been doing for many years. We bring partners on board to create together and pay appropriate compensation for that work. Through this approach, we aim to grow together with our partners.

— Co-creation is also a key point in recent initiatives.

The development of ammonia-fueled vessels is a prime example of co-creation. Following the completion of the ammonia-fueled tugboat Sakigake, we plan to complete an ammonia-fueled medium gas carrier (AFMGC) in November 2026. We are working with Nihon Shipyard Co., Ltd. (NSY),



the Ariake shipyard of Japan Marine United Corporation (JMU), Japan Engine Corporation, IHI Power Systems Co., Ltd., and Nippon Kaiji Kyokai (ClassNK) to construct vessels and manufacture main and auxiliary engines. In this project, NYK plays the role of facilitator. These key players have a common motivation to work together in an all-Japan effort, clarifying their respective roles and schedules based on the principle that each specialist focuses on what they do best, while sharing information and moving toward the same goal. As a result, we were able to move quickly to the design and keel-laying stages.

The Nippon Foundation's fully autonomous ship program "MEGURI" follows a similar structure. Japan Marine Science Inc., an NYK Group company, plays a central role, and each project participant fulfills their own responsibilities. As a shipping company, we are working on the development of collision avoidance systems and shore-based remote ship operation systems. MEGURI has now entered its second phase, and progress has also been made on discussions to establish systems that will be accepted by society. Even if the vessels are built, commercialization is not possible unless the surrounding social frameworks are in place.

Experts take responsibility for their own fields of expertise and proceed while sharing the same goals and schedules. I

feel that these projects represent an ideal form of co-creation.

Creating Demand By Sharing New Technologies

— It seems that your range of partner companies is expanding.

In addition to private companies, government ministries, agencies, and local governments are also providing various forms of cooperation. Using ammonia-fueled vessels as an example, ammonia supply bases are required, so support from public authorities is indispensable. I believe that Japan is an environment in which new initiatives can be realized through collaboration.

— There is an impression that NYK does not keep the technologies and systems it develops to itself, but instead shares them across the entire industry.

This is something we are very conscious of. There is no

point in developing technologies if they are not widely adopted. Supply does not emerge unless demand is created, so we believe it is necessary to make developed technologies as open as possible. This was also the case with LNG-fueled vessels. Demand and supply have a “chicken-and-egg” relationship, and as the number of LNG-fueled vessels increased, LNG fuel bunkering bases expanded around the world. We need to do the same with ammonia. If we take the attitude that “this is our exclusive technology,” neither demand nor supply will be created, and the technology will not spread.

Of course, it is necessary to distinguish between competitive areas and cooperative areas, but for those areas where cooperation is appropriate, it is important to increase the number of partners while making results as open as possible. NYK has long had an awareness of its role as an industry leader. Rather than seeking benefits only for ourselves, we have operated with the mindset of creating a common foundation together with others. That stance has not changed.

Taking Steps Toward Enhancing the Competitiveness of Japanese Shipbuilding

— How will you contribute to revitalizing Japan’s maritime cluster from a technological perspective?

I would like Japanese shipyards to further enhance their competitiveness. One way we are helping to achieve this is by addressing the personnel shortage at the design stage. Shipyards have not increased the number of personnel responsible for design, and in reality, they are unable to allocate sufficient resources to the development of vessels incorporating new technologies. This is one reason they are falling behind shipyards in China and South Korea. That is why it is important to first create an environment that attracts talent into the shipbuilding industry. If the number of new entrants remains limited, it becomes even more important to determine how efficiently design work can be carried out with a limited number of personnel and how efficiently the shipbuilding process can be operated.

To this end, through the Industry-Academia Collaborative Program “Maritime and Ocean Digital Engineering Program” (MODE Program), established at the Graduate School of Frontier Sciences of the University of Tokyo, and the government’s Key and Advanced Technology R&D through Cross Community Collaboration Program (K Program), we are advancing the construction of platforms for next-generation ship development using simulation technologies, enabling highly advanced design in a shorter period of time. Furthermore, through the Joint Research Program “Open Collaboration Laboratory for Enabling Advanced Marine Systems (OCEANS),” established at the Graduate School of Engineering of the University of Osaka, we are promoting initiatives to further improve on-site efficiency and reduce labor requirements by



incorporating artificial intelligence (AI) and robotics. The NYK Group is also participating in these initiatives. Conducting such advanced research at Japanese shipyards may also serve as an appeal to young talent, including engineering students.

However, simply providing support is not sufficient. Ultimately, our efforts only have meaning if we actually place orders for vessels with Japanese shipyards and use them ourselves. Until now, shipping companies and shipyards have had their own preferences. Japanese shipyards have regarded their designs as a means of differentiation and have focused on creating vessels that differ from those of other companies, for example, through hull form and fuel efficiency. Shipping companies have also made demands on shipyards, insisting on certain NYK vessel specifications. However, given the limited human resources at shipyards and the limited variety of hull forms they can build, standardization is necessary from the perspective of efficiency. If standardization can be achieved, whereby multiple shipyards build vessels of the same design and multiple shipping companies use them, this will contribute not only to greater efficiency but also to addressing labor shortages and lengthy construction periods.

LNG-fueled vessels and ammonia-fueled vessels require approximately one and a half times the construction period of conventional vessels. To shorten construction periods, I believe the two-pronged approach I have described is essential. Ultimately, the goal is for us to take responsibility for purchasing the vessels developed through these efforts and operating them in our fleet. I believe that the framework for taking that step is now coming into place.

From the perspective of economic security, the Japanese government has identified shipbuilding as an important sector. A support framework involving government, industry, and academia is being established. By making effective use of that support, I hope we can enhance the international competitiveness of Japanese shipyards. We are now standing at the starting line.

Navigation Officers and Engineers as the Source of Competitiveness

Hisaya Higuchi

Managing Executive Officer



Leveraging Onboard Expertise in Shore-Based Operations

— With the introduction of new technologies on vessels and expansion into new business domains, what skills and knowledge will seafarers and navigation officers and engineers need going forward?

With environmental measures centered on reducing greenhouse gas (GHG) emissions in shipping, which is currently the most significant trend, there is a need to transition to new fuels. Many new businesses are also being developed in close connection with environmental initiatives. As navigation officers and engineers, we have firsthand onboard experience as seafarers, and from a user's perspective, we understand both the strengths of vessels and the areas that require improvement through direct experience. I believe it is important to cultivate personnel who can feed this knowledge back into various shore-based projects. For younger employees, we first want them to thoroughly learn onboard operations through service at sea. They can then apply the experience and knowledge gained there to various shore-based departments. Ensuring safe navigation is a fundamental prerequisite, and beyond that, we seek individuals who can fully demonstrate their maritime expertise.

— What do you expect non-Japanese seafarers and navigation officers and engineers play?

Our basic approach toward non-Japanese personnel is the same as for Japanese personnel. However, since the number of Japanese seafarers is small, non-Japanese seafarers naturally have more opportunities to be active as onboard personnel. Their major expected role is to serve on vessels equipped with new technologies and new fuels and to ensure safe navigation. Some personnel also have the aptitude to work in shore-based positions both in Japan and overseas, just as we do with Japanese staff. There are navigation officers and engineers from overseas working at our Tokyo headquarters as well, and we hope to see more of such personnel in the future.

— Japanese navigation officers and engineers are also involved in building new types of vessels.

One example is the construction project for an ammonia-fueled medium gas carrier (AFMGC) scheduled for completion in November 2026. Japanese and non-Japanese crew members will initially operate the vessel together, and over time, we expect operations to be handed over to fully non-Japanese crews.

— Are opportunities for navigation officers and engineers to play an active growing?

Assignments for navigation officers and engineers have expanded beyond traditional ship-management companies and marine departments to include business divisions for car carriers, bulkers, tankers, LNG carriers, as well as Ocean Net-

work Express Pte. Ltd. (ONE), a container shipping company. In recent years, expansion has been particularly notable in new business and green business domains. These include crew transfer vessel (CTV) operations for offshore wind power generation, offshore businesses, and next-generation fuel projects, all of which create many situations in which Japanese navigation officers and engineers are needed. As a result, there is a perceived shortage of such personnel. To address this, we have made adjustments such as having non-Japanese personnel take on roles that were previously handled by Japanese staff, while assigning those staff to new business domains.

There are approximately 630 Japanese seafarers at our company, about half of whom are engaged in sea service (including seafarers on leave) and about half are assigned to shore-based positions. In addition to graduates from maritime education institutions, about 20% are employees who joined the company after graduating from general universities and other institutions; they are assigned after completing a government-designated seafarer training program (hereinafter referred to as the “in-house training program”). Under the in-house training program, employees follow a government-designated qualification acquisition program after joining the company, which requires two years to complete from when they start the program to when they acquire the national certifications. However, we do not believe there is any difference in their capability as navigation officers and engineers, nor are there any differences in career paths or opportunities after the qualifications are obtained.

Companywide Efforts to Improve Conditions for Navigation Officers and Engineers

— NYK has launched CX NEO (NYK Empowering Oceans), an initiative focused on Japanese navigation officers and engineers. What kind of project is this?

The impetus for this project was the relatively low scores for Japanese Navigation officers and engineers in an internal engagement survey. They voiced a variety of concerns regarding onboard living environment, working styles, and treatment. At the same time, the “technical expertise related to vessel construction and operation” possessed by them can be described as a “source of our competitiveness.” As initiatives for GHG reduction, including the adoption of next-generation fuels and the expansion of green businesses, continue to progress, the importance of Japanese seafarers as technical personnel has once again been recognized within the company.

With both the challenges surrounding these officers and engineers and the needs of business operations coming into focus at the same time, we launched “CX NEO” in April 2024

with the aim of “reexamining the role of Japanese seafarers and navigation officers and engineers, enhancing the desirability of their work, and addressing issues from multiple perspectives in order to build an environment in which they can work more positively.” Through this initiative, we believe it is essential to firmly safeguard the technical expertise related to vessel construction and operation, which can be regarded as a source of NYK’s competitiveness.

In the past, initiatives to improve working styles and related matters had been undertaken by individual departments; however, many of these efforts were led primarily by Japanese navigation officers and engineers themselves and were limited in scope. Under CX NEO, however, we have reframed “improving the conditions of navigation officers and engineers” as a companywide issue and positioned the initiative as a cross-departmental, organization-wide effort. A major difference from previous approaches is that video messages from the president and other executives, along with various types of information, are continuously shared across the entire company in an environment accessible to both shore-based and sea-based staff, thereby aligning understanding companywide and promoting the initiative as a companywide activity. In addition, opportunities for face-to-face dialogue with Japanese navigation officers and engineers have been established to continuously gather feedback from the field, discuss issues, and reflect them in policy improvements.

The initiatives under CX NEO cover a wide range of areas. We discuss a broad array of themes, including improvements in compensation, leave, and benefits, the optimization of onboard service periods, workload reduction through the digitalization of operations, and the expansion of opportunities for the officers and engineers, and we prioritize these topics as we work to implement improvements. For example, with regard to onboard environment, we are enhancing living quarters through the introduction of high-quality mattresses (bedding) and reviewing onboard meals. Because communication infrastructure is also critical onboard, high-speed satellite communication using “Starlink” has already been installed on the majority of vessels. In addition to its use for business purposes, this has significant value in enabling seafarers to communicate with their families. We are also collaborating with Tama Art University to develop workwear that is safe, comfortable, and appealing to wear. Furthermore, we have launched a “housekeeping support trial” for families at home while crew members are onboard.

Under CX NEO, we are also engaging in discussions on career paths for Japanese navigation officers and engineers. In the past, a typical career model involved alternating between sea service and shore-based assignments and aiming to become a captain or chief engineer in one’s late 30s. Today, however, family and personal circumstances vary widely, and we will introduce greater flexibility into career paths and put in place systems that enable a wider range of diverse careers.

We do not view this project as a one-time initiative, but rather as an effort that should be pursued on an ongoing

basis. While initiatives such as those related to career development are personnel measures targeting Japanese staff, measures such as improvements to onboard conditions are initiatives that also affect non-Japanese seafarers.

Enhancing the Safety of Operating Vessels

— Can you explain the structure and systems for ship management that support safe navigation?

With regard to ship management, NYK Shipmanagement Pte. Ltd. (NYKSM), headquartered in Singapore, is expanding its ship management operations in India. While the Singapore office will continue to function as the core center of expertise, ship management operations there will focus primarily on energy transport vessels, whereas the India office will mainly manage bulkers and car carriers. The Manila, Philippines office will also be kept; however, it will transition away from serving as a ship management hub and instead strengthen functions such as crew management.

In Japan, three companies, Asahi Shipping Co., Ltd., Hachiuma Steamship Co., Ltd., and Mitsubishi Ore Transport Co., Ltd., will merge in April 2026 to establish a new ship-management company, NYK Bulkship Partners Co., Ltd. (NBSP), which will manage bulkers, car carriers, and other vessels. Priority will first be placed on ensuring the stable operation of the new company, and the division of roles with NYKSM will be adjusted at a later stage.

In addition to NYKSM and NBSP, the existing management

structure for LNG carriers, which spans Japan, the United Kingdom, Singapore, France, and Taiwan, will be maintained. Going forward, as NYK Group's LNG fleet is expected to expand rapidly, we will examine the optimal management framework through discussions with the relevant business divisions.

— Management of vessels using new fuels is also expected to increase.

For LNG-fueled vessels, in addition to NYKSM, Mitsubishi Ore Transport and Hachiuma Steamship, which will form part of the new company NBSP, have accumulated management experience, enabling us to respond effectively while leveraging existing expertise. On the other hand, the management of vessels fueled by ammonia and other fuels expected to follow LNG will initially be handled by NYKSM in Singapore, with plans to expand this to other group ship-management companies once operations have stabilized.

— Regarding ship management for owned and flag of convenience (FOC) vessels, are there also initiatives to enhance the safety of all operating vessels, including chartered vessels?

We follow original safety standards we call "NAV9000." In April 2026, we will begin using a renewed version of these standards, "NAV9000 Plus." While partially revising requirements for shipowners and ship-management companies, the new framework will place greater emphasis on dialogue. Based on the philosophy of guidance and co-creation, we will prioritize dialogue and work with all stakeholders to further enhance overall safety quality.

Opportunities to Take on Challenges, Both in Japan and Overseas

— As a managing executive officer who is also a maritime officer, what inspired you to pursue this career path?

The initial trigger was watching a television anime in which the main character boarded a vessel, which sparked my interest in the profession of seafaring. In addition, my maternal family home was near the Ariake Sea, and I had many opportunities to ride on vessels from a young age, which also influenced me.

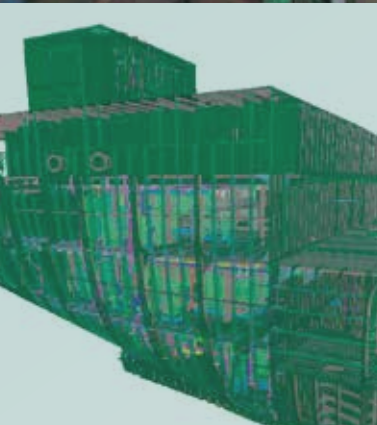
— Is there anything you would like to convey to those aspiring to become navigation officers and engineers at NYK?

Students often say after completing internships that they had imagined NYK to be a much more rigid company,

but found it to be open and approachable. There is an atmosphere in which people can speak freely, and an environment where voices are listened to attentively.

Another major attraction is the opportunity to take on challenges in Japan and overseas from an early stage in one's career while carrying the NYK name. I also make a point of telling new employees that NYK is a company that properly recognizes and evaluates those who make an effort. We warmly welcome individuals who wish to expand their own potential.

NYK is a company that clearly positions navigation officers and engineers as a source of its competitiveness, and therefore provides a foundation in which motivated individuals making sustained efforts can expect to be fairly evaluated.



PROJECT

- ▶ Investing in MILES for Next-Generation Ship Development
- ▶ NAV9000 Plus: An Evolving Safety Standard
- ▶ MEGURI2040: Fully Autonomous Ship Program
- ▶ MarCoPay and Kadmos: E-Money Services for Seafarers
- ▶ AI-Based Vessel Allocation System for Car Carriers
- ▶ Pioneering Ship Design with 3D Models



Revitalizing Japan's Shipbuilding Industry Through an All-Japan Effort

Investing in MILES to Centralize Next-Generation Vessel Development and Basic Design

The Japanese shipbuilding industry is approaching a major turning point. Amid the irreversible global trend toward decarbonization, ships have become more complex than ever before, and the burdens of design and development have increased significantly. At the same time, structural issues faced by the domestic shipbuilding industry, namely a shortage of design engineers and the fragmentation of design resources, are reaching a level that exceeds what individual companies can handle independently. Confronting this reality, NYK is advancing initiatives to support the revitalization of Japanese shipbuilding.

Creating a Design Platform Through an Alliance of Seven Companies

NYK, together with major shipping companies Kawasaki Kisen Kaisha, Ltd. and Mitsui O.S.K. Lines, Ltd., as well as major shipbuilders Mitsubishi Shipbuilding Co., Ltd., Imabari Shipbuilding Co., Ltd., Japan Marine United Corporation (JMU), and Nihon Shipyard Co., Ltd. (NSY), has set out to establish a standard design framework under which common basic designs for next-generation vessels will be developed and rolled out to domestic shipyards. The framework's targets include liquefied carbon dioxide (LCO₂) carriers and new-fuel vessels such as ammonia-fueled vessels. These vessel types will form the main battleground in the decarbonization era.

At the core of this initiative is MILES Co., Ltd., a joint venture between Mitsubishi Heavy Industries, Ltd. and Imabari Shipbuilding, formerly known as MI LNG Company, Ltd. NYK, together with the other six companies, has invested in MILES and will build a development and basic design framework centered on this company. Shipping companies as vessel users and shipyards as vessel manufacturers are jointly creating a common design platform. This framework, long discussed in the Japanese maritime industry, has finally come to be.

NYK has long regarded the restoration of the Japanese shipbuilding industry's international competitiveness as its own responsibility. President Takaya Soga stated, "We want Japanese shipyards to become even more competitive." To this end, the company has begun taking action from a shipping company's perspective.

The shipbuilding industry is suffering from a manpower shortage in the design stage. While it is essential to create an environment that attracts talent, competitiveness also depends on how efficiently design work can be carried out with a limited number of engineers, and on how rationally the shipbuilding process can be managed. One solution to this challenge is to utilize MILES as the core to consolidate

development and basic design of next-generation vessels.

LCO₂ carriers and new-fuel vessels require far more design considerations than conventional commercial vessels, resulting in enormous development and design workloads. In Japan, however, design resources are dispersed among individual companies and are insufficient overall. To overcome this inefficiency, the concept of a "Japanese version of the Shanghai Merchant Ship Design & Research Institute (SDARI)" emerged.

In China, the established model is that institutes such as SDARI undertake basic design on a centralized basis while shipyards utilize the resulting standardized drawings. In Japan as well, there has been a long-running exploration of a division of labor based on standard basic designs. By having shipping companies and shipbuilders jointly invest in MILES, the company will further strengthen its role as a joint design center for the Japanese maritime cluster.

Toward Collaboration Beyond Industry Boundaries

What is essential is that the maritime transportation companies themselves, as the entities that place orders for vessels, have decided to invest in MILES to accelerate collaboration beyond traditional industry boundaries in Japan. Based on this decision, they will work to promote vessel construction at a wide range of domestic shipyards by utilizing a design framework centered on MILES. To support this, "standardization of specifications" is also being considered.

President Soga stated, "If standardization can be achieved whereby multiple shipyards build vessels having the same design and multiple shipping companies use those vessels, this will contribute not only to greater efficiency but to addressing labor shortages and the prolongation of construction periods."

In 2025, the Japanese government announced support measures aimed at reviving the shipbuilding industry and set

a target to restore shipbuilding capacity to 18 million gross tons by 2035. Moreover, investments totaling approximately one trillion yen from both the public and private sectors are taking concrete form. However, merely increasing construction volume will not ensure international competitiveness. Alongside capital investment, it is necessary to change the design approach fundamentally and to deepen collaboration between shipping companies and shipbuilders.

Initiatives to reform design and development methodologies are also underway. Alongside the University of Tokyo's research into model-based development through its industry-academia collaborative Maritime and Ocean Digital Engineering Program (MODE Program), the University of Osaka has launched the Open Collaboration Laboratory for Enabling Advanced Marine Systems Program (OCEANS), which applies AI to ship design. Furthermore, development of a simulation platform has begun under the Cabinet Office's Key and Advanced Technology R&D through the Cross Community Collaboration Program (K Program). These initiatives are led by MTI Co., Ltd., which is responsible for R&D within the NYK Group.

NYK Chairman Hitoshi Nagasawa has stated, "Restoring the Japanese maritime cluster to be an attractive industry and passing it down to future generations is the responsibility of all of us here today." Now serving as chairman of the Japanese Shipowners' Association, he is spreading this vision

across the entire industry.

Government support, capital investment, design innovation, and standardization—NYK, as a vessel user, is supporting the Japanese shipbuilding industry's efforts to achieve ambitious goals, namely becoming the world's top market share holder in next-generation vessels by 2030 and restoring construction volume to 18 million gross tons by 2035.



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THE FUTURE



“NAV9000 Plus”

— An Evolving Proprietary Safety Standard Raising Safety Quality Through Guidance and Co-creation

In April 2026, NYK will further evolve its original safety standards, “NAV9000.” Introduced in 1998 with the aspiration of ensuring a shared level of safety across all operating vessels, not just the company’s owned vessels but charters as well, these safety standards have supported NYK’s safe navigation for more than a quarter century. This initiative has never been an effort by NYK alone. Together with partners including ship owners and ship-management companies, the company has consistently addressed safety, the foundation of shipping company management. This initiative, renewed as “NAV9000 Plus,” aims to achieve a higher level of safety through the spirit of guidance and co-creation. Under the philosophy of “Without safety, there is no trust; without trust, there is no business,” NYK will deepen collaboration with all stakeholders while pursuing both safety and quality.

Pioneering Quality Assurance in the Shipping Industry

“NAV9000,” the original safety standards applied to vessels operated by the NYK Group, as well as to shipowners and ship-management companies, were introduced with the objective of enabling NYK to fulfill its responsibilities as an operator for safe navigation and environmental protection. In the late 1990s, the prevailing view in the maritime industry was that the primary responsibility for safety management lay with shipowners and ship-management companies. However, from shippers’ perspective, NYK believed that regardless of vessel ownership and management structure, the company itself as an operator should be the party directly responsible for achieving safe navigation. “NAV9000” clearly demonstrated that commitment.

The introduction of “NAV9000” coincided with the period when the International Safety Management Code (ISM Code) entered into force based on the International Convention for the Safety of Life at Sea (SOLAS) of the International Maritime Organization (IMO). Managing Executive Officer Hisaya Higuchi, who is in charge of the Marine Group, reflects, “The Safety Management Systems (SMS) established by ship-management companies in accordance with the ISM Code represented the minimum framework necessary to ensure safe navigation and marine environmental protection. Our starting point was to create a standard that also incorporated the requirements of NYK and of charterers.”

The history of “NAV9000” can be seen as the pioneering of quality assurance within the maritime industry. The name “NAV9000” reflects the philosophy of the international quality management standard “ISO 9000,” which has been incorporated into the ISM Code. Safety and quality improvement activities conducted under “NAV9000” have been certified under the international quality management system stan-

dard “ISO 9001:2015” by Nippon Kaiji Kyokai (ClassNK).

“NAV9000” consists of three major elements. The first element consists of requirements based on the four major international conventions related to international shipping (*). The second element consists of the proprietary requirements of NYK, such as measures to prevent the recurrence of accidents and good practices cultivated through experience. The third element consists of industry requirements, which are driven by charterers.

These requirements are clearly documented, and ship-owners and ship-management companies are required to implement them. Among the requirements that NYK has implemented as original standards, over time, some have become standard requirements across the maritime industry.

Compliance with the requirements is verified through the “NAV9000 Assessment,” a framework for evaluating vessels and ship-management companies. The checklist consists of approximately 1,500 items, and its scope covers around 800 vessels operated by the NYK Group as well as roughly 80 shipowners and ship-management companies that own or manage those vessels. On an annual basis, assessments are conducted for approximately 200 vessels and about 20 companies. All targets are covered during a several-year cycle, which is repeated continuously. All vessels are evaluated using the same indicators, regardless of whether they are owned vessels, flag of convenience (FOC) vessels, or chartered vessels.

Vessel assessments are conducted primarily by Indian and Filipino Master and Chief Engineer and are carried out



NAV9000Plus logo

* The International Convention for the Safety of Life at Sea (SOLAS), the International Convention for the Prevention of Pollution from Ships (MARPOL), the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), and the Maritime Labour Convention (MLC).

over the course of a day at ports of call in Japan, South Korea, China, and Southeast Asia. Company assessments, which are conducted over two days, are mainly handled by Japanese Masters and Chief Engineers, and in recent years, Indian and Filipino Masters and Chief Engineers have accompanied them in order to gain experience.

Evaluations are conducted on a five-point scale, ranging from the highest rating of “5” to “1,” which indicates an extremely high likelihood of accidents or delays. Even when a low rating is assigned, chartering is not immediately suspended; instead, improvement activities are supported. This approach reflects the framework’s philosophy, which places “dialogue” at its core.

Based on the assessment results, shipowners and ship-management companies have implemented the necessary improvement measures, which have led to the steady accumulation of improvements in safety and quality. Regarding these outcomes, Michio Suzuki, Captain, manager of Marine Group’s Global Maritime Quality Assurance Team, states, “Dialogue-based assessments make a significant contribution to raising the level for safety quality.”

Assessment effectiveness is further supported by objective data. In 2024, the average downtime across the entire fleet (the time during which operations were suspended due to accidents or trouble) was 23.2 hours. However, when limited to the 182 vessels for which assessments were conducted in the previous year, the average downtime was 9.5 hours, achieving the target of “within 10 hours.” Moreover, among the 152 vessels with high evaluation scores of 3.0 or higher, the average downtime was 6.4 hours, while vessels with scores of 2.9 or lower recorded an average of 25.2 hours, a clear difference. Regular assessments help to maintain safety standards.

The Main Players: The Crew and Ship-Management Companies

Nearly thirty years have passed since the introduction of “NAV9000,” and during this time, international regulations

and industry safety standards have become more stringent. Vessels and ship-management companies have also been subject to various external audits in addition to “NAV9000,” and there has been a growing sense that attention is shifting toward external audits that directly relate to shippers, such as those conducted by the Oil Companies International Marine Forum (OCIMF), which is composed of major oil companies, and vessel inspections conducted by RightShip, a ship rating company that is supported by major resource companies. Suzuki explains, “There was also an increased burden on crews and ship-management companies caused by overlapping audits and assessments. Rather than repeating the same checks, we wanted to clearly define what made ‘NAV9000’ unique and renew it in a way that would enhance its value.” To further improve safety quality and to reliably fulfill the company’s responsibilities as an operator, it was determined that a safety standard that ensured a more advanced safety management framework and greater effectiveness was required.

In this way, the evolved version called “NAV9000 Plus” was formulated. While inheriting the fundamental philosophy and framework, “NAV9000 Plus” places greater emphasis on “guidance,” “co-creation,” and “dialogue,” and aims to further enhance the safety quality of operating vessels through attentive follow-up with vessels, shipowners, ship-management companies, and other related parties.

There are four major enhancements regarding the evolution of “NAV9000 Plus.”

The first is the establishment of the “Golden Rule,” which clearly defines non-negotiable safety values.

Chief Officer Shun Hamazaki, Global Maritime Quality Assurance Team, explains, “From the extensive requirements, which amount to approximately 1,500 items when compiled into a checklist, we identified those elements that NYK absolutely cannot compromise on in order to achieve our safety goals of limiting downtime to within 10 hours and achieving zero serious accidents.”

The second enhancement is the introduction of evaluation sheets that clearly present assessment results. The third is the establishment of a comprehensive follow-up frame-



NAV9000 Plus assessment



■ “NAV9000 Plus” Enhanced Features

Establishment of the Golden Rule	The ore commitments directly linked to accident prevention are shared among all stakeholders. ● Seamanship (rules related to occupational health and safety): Safe behaviors such as wearing helmets, proper maintenance of lifesaving and firefighting equipment, and an emphasis on communication ● Navigation (rules related to navigational operations): Proper lookout and information sharing to prevent navigational accidents such as collision and grounding accidents, and an attitude of taking immediate action if there are elements of concern ● Engineering (rules related to engine operations): Thorough inspections and maintenance without compromise, patrols and monitoring using all five senses, and a deeper understanding of machinery in preparation for emergencies
Introduction of Evaluation Sheets	Previously, assessment results were presented only in terms of scores and requests for corrective action. Under the new approach, scores are broken down by category and presented visually, clearly identifying strengths and weaknesses. Requests for corrective action are no longer limited to pointing out issues. By explaining why an issue occurred and what could happen if it is left unaddressed, the framework enables stakeholders to share a clear understanding of the necessity for improvement.
Establishment of the Ambassador Program	Under the previous approach, after requests for corrective action were issued, the period until the next assessment effectively became an observation phase, and follow-up was not always sufficient. To address this, employees who have a deep understanding of the “NAV9000 Plus” concept are appointed as ambassadors in each business division, including bulk carriers, car carriers, LNG carriers, and tankers. Through activities such as onboard visits, ambassadors provide thorough follow-ups based on the assessment results.
Optimization of approaches according to ship-management structure	Support methods are differentiated between external ship-management companies and those within the NYK Group. For external ship-management companies, the Marine Group collaborates with each business division to provide follow-ups centered on ambassadors. For ship-management companies within the NYK Group, in addition to follow-ups by ambassadors, improvement is encouraged more deeply from within through measures such as accompaniment during internal audits.

work provided by “ambassadors” who are assigned to each vessel-type business division. The fourth is the optimization of approaches according to ship-management structure. A wide range of measures to enhance effectiveness have been incorporated.

In operating “NAV9000 Plus,” NYK emphasizes that “the main players are the crew and the ship-management companies.” NYK positions itself as a guide that stays close to those on the front lines who are striving to move forward and confront challenges together. For this reason, even greater emphasis is placed on “dialogue” in operations. Rather than merely identifying deficiencies through vessel and company assessments, the company presents concrete prescriptions for improvement and conducts regular follow-ups. Higuchi states, “By working together and playing a role like that of a family doctor to enhance quality, we support and co-create

so that each company and each vessel can appropriately respond to shippers’ requirements.”

In addition, some requirements will be revised. Since the most recent revision in 2017, there has been an increase in the number of initiatives led by shippers, including “DryBMS,” an evaluation framework for ship-management companies established by the dry bulk industry. In response, measures that had previously been positioned as recommendations will be added to the formal requirements. By incorporating various requirements from shippers, the aim is to create a framework that ensures compliance with “NAV9000 Plus” will enable vessels to clear the majority of inspections conducted by shippers, as well as inspections conducted by port states, including port state control (PSC).



Key Figures Driving the Project

Connecting a Safety Culture by Learning from the Past

Michio Suzuki Captain and Manager

Shun Hamazaki Chief Officer

Global Maritime Quality Assurance Team, Marine Group

Michio Suzuki (left) and
Shun Hamazaki (right)



— What inspired you to pursue a maritime career, and what roles have you held at NYK?

Suzuki: I originally aspired to become an airplane pilot, but my eyesight did not meet the requirements, so I decided to enter the maritime field. I enrolled at Tokyo University of Mercantile Marine (now Tokyo University of Marine Science and Technology), and by a turn of fate, joined NYK in 2001. During my onboard assignments, I mainly served on LNG carriers and also worked on heavy-lift vessels. From my sixth year with the company onward, I alternated between onboard and shore-based assignments. On shore, I gained experience in Quality Assurance work at an LNG carrier ship-management company and in crewing work at a ship-management company in Singapore. I was also involved in examining business models during the establishment of MarCoPay Inc. Later, amid the unprecedented circumstances of the COVID-19 pandemic, I served for the first time as a Master on an LNG carrier, and I am now assigned to the Marine Group.

Hamazaki: I joined the company in 2017 and now serve as a chief officer. I began aspiring to a career at sea after enrolling at Tokyo University of Marine Science and Technology. I initially chose that university because I wanted to study in Tokyo, but through onboard training, I became fascinated with seafaring work. During my onboard assignments, I have served on a wide range of vessel types, including car carriers, containerships, bulk carriers, LNG carriers, and LPG carriers. In June 2023, I began my first land-based role, and I am now engaged in safety promotion activities, including work related to “NAV9000.” Before joining the company, I had some concerns about extended periods at sea, but once I actually went aboard, I found it enjoyable and time flew by. Now, while working onshore, I am surprised to find myself wanting to return to sea.

— What does the “NAV9000 Plus” project mean to you personally?

Suzuki: Nearly thirty years have passed since “NAV9000” was established, and 2025 was also a milestone year marking NYK’s 140th anniversary. I feel a sense of destiny in being involved in this renewal at such a timing. On my first voyage, the captain handed me the “NAV9000” checklist and told me, “Study this,” thoroughly instilling in me the importance of safety quality. Later, I also had opportunities to engage in

safety management work at an LNG carrier ship-management company, and all of these experiences connect directly to what I am doing today. Because this renewal represents a major milestone, I am determined to make it a success. The practical work of the project is being led mainly by younger personnel, and I want to ensure that this framework is firmly passed down to the generations that will lead NYK in the future.

Hamazaki: This project’s appeal lies in being able to consider how “NAV9000,” which has underpinned safety quality at NYK, should evolve over the next ten, twenty, and thirty years. We have reviewed materials from when the standard was established in 1998 and, drawing hints from them, are deepening the initiative by incorporating contemporary perspectives. This is truly an example of learning from the past to develop new insights, and I am approaching this project with a strong sense of responsibility.

— What is your message to those who want to become navigation officers and engineers at NYK?

Hamazaki: At sea, you will serve on a variety of vessel types and experience different ranks. Even on shore, the knowledge and skills required differ greatly depending on the work involved. Continuous self-improvement is therefore essential, but the opportunity to constantly engage in work that is fresh and stimulating is very attractive. I hope people who are interested in the world of international seafaring choose to aim for a career at NYK.

Suzuki: I feel that NYK offers an open and flexible working environment, and I have a deep sense of fulfillment as a seafarer. I experienced the Great East Japan Earthquake while serving as a junior chief officer on an LNG carrier. After the disaster, amid the tight power supply conditions, I was involved in LNG transportation as a chief officer and strongly felt how we were supporting social infrastructure. During the COVID-19 pandemic, I served as a Master on an LNG carrier and engaged in transportation to meet customer needs amid the rising electricity demand associated with an increase in the number of people staying at home. Through these experiences, I came to feel that I was playing a part in supporting people’s daily lives. Transportation work is directly connected to society and how people live. I believe that following the path of navigation officers and engineers allow one to take pride in such a contribution.



MEGURI2040 Fully Autonomous Ship Program

Solving Social Issues by Developing World-leading Technologies

The NYK Group plays a central role in the Nippon Foundations MEGURI2040 Fully Autonomous Ship Program, which targets Japan's coastal shipping sector. In Stage 2 of this project, the aim is to achieve conditional autonomous navigation, which is defined as an automation level at which fully autonomous navigation is partially possible, equivalent to Level 4 for self-driving automobiles. As a result, the project is attracting global attention as one of the most advanced initiatives in the maritime industry. Through an all-Japan effort involving not only the maritime industry but participants from other industries, the project is advancing the development of cutting-edge technologies while working to establish rules for social implementation and to foster public understanding through information dissemination. The project outcomes will also form a foundation for Japan to take the lead in the development of international rules on autonomous ships at the International Maritime Organization (IMO).

Toward Social Implementation and the World's First Commercial Operation

The Nippon Foundation's MEGURI2040 is a project that promotes technological development with the aim of realizing fully autonomous ships in order to address social issues such as the labor shortage in the coastal shipping sector caused by Japan's aging and declining population as well as marine accidents resulting from human error, while strengthening the competitiveness of Japan's maritime industry. In Stage 1 of the project, which was implemented from 2020 to 2022, demonstration voyages of fully autonomous navigation by coastal vessels were successfully carried out ahead of the rest of the world, involving five consortia and six vessels. Building on this achievement, in Stage 2, which began in 2023, the aim is not only to conduct social trials of fully autonomous navigation but to significantly advance social implementation.

In Stage 2, members of the consortia that participated in Stage 1 have united under a single framework, forming an all-Japan consortium consisting of 53 companies. Including



Permanent FOC

domestic and overseas partner organizations, the consortium involves more than 100 entities that are advancing development through open innovation. Participation extends beyond the maritime cluster—which includes shipping, ship-building, and marine equipment companies—to companies from other industries. Stages 1 and 2 each are projects on the

Stage 2 Demonstration Vessels for MEGURI2040

Demonstration Vessel	Main Development Leaders	Commercial Service Route
Remote Island Passenger Ferry Olympia Dream Seto (Length Overall: 65 m)	Japan Marine Science (Leader), Kokusai Ryobi Ferry, Tsuneishi Solutions Tokyobay, Mitsubishi Shipbuilding, Furuno Electric	Shin-Okayama Port - Tonosho Port (Shodoshima Island)
Coastal Containership Mikage (Length Overall: 95 m)	Mitsui O.S.K. Lines (Leader), Imoto Lines, Furuno Electric, Tsuneishi Solutions Tokyobay	Kobe - Nagoya
Coastal Ro-Ro Cargo Ship Hokuren Maru No. 2 (Length Overall: 173.8 m)	Kawasaki Kisen Kaisha (Leader), Kawasaki Kinkai Kisen Kaisha, Japan Radio, YDK Technologies	Kushiro - Hitachi
Newly Built Coastal Containership Genbu (Length Overall: 126.8 m)	MTI (Leader), Ikous, Japan Marine Science, Japan Marine United, Furuno Electric, BEMAC, Tokyo Keiki, Nabtesco, Sunflame, Tsuneishi Solutions Tokyobay, Space Compass, JRCS, Terasaki Electric, Naiken R&D, Weathernews, EIZO	Kobe - Osaka - Nagoya - Yokohama



Mobile FOC(The Nippon Foundation)



Autonomous navigation equipment installed on Olympia Dream Seto (The Nippon Foundation)

scale of approximately 10 billion yen, with more than 80% of the funding provided by the Nippon Foundation.

In terms of technological development, the project is working on autonomous maneuvering; automated berthing, unberthing, and mooring technologies; simultaneous remote support of multiple vessels; and the establishment of more stable ship-to-shore communication. Demonstrations of fully autonomous navigation will be conducted using a total of four vessels having different ship types, designs, and routes, consisting of two containerships (including a newly built vessel), one existing Ro-Ro vessel, and one remote-island passenger ferry. These demonstrations will be supported by two types of Fleet Operation Centers (FOCs), namely a permanent center and a mobile center designed for disaster response. The initiative places strong emphasis on social implementation, including simultaneous monitoring and support of multiple vessels from the FOCs. Providing navigational support from shore to multiple fully autonomous ships at the same time is a world first.

The four demonstration vessels are shown in the accompanying table. The FOC equipped with all shore support functions—including operation monitoring of multiple vessels, individual support for navigation functions and engine functions, and voyage planning—has been completed on the premises of Furuno Electric Co., Ltd. in Nishinomiya City, Hyogo Prefecture. In addition, a mobile FOC has been developed by Japan Radio Co., Ltd. that compactly integrates the functions required for shore support, enabling simultaneous monitoring of multiple vessels with an eye toward future widespread adoption and ensuring redundancy during disasters.

Because the project aims at social implementation, it places importance not only on technological development but on rulemaking and fostering social understanding of fully autonomous ships for future generations. With regard to rulemaking, the project seeks to achieve social implementation through deregulation while strengthening the competitiveness of Japan's maritime industry through international standardization.

Unlike automobiles, it is difficult to test ships using full-scale physical prototypes. For this reason, simulation technologies are also utilized during the design phase. The project further serves as a venue for putting into practice digital

engineering methods that make use of simulation technologies developed under the University of Tokyo's industry-academia collaborative Maritime and Ocean Digital Engineering (MODE) Program, in which the maritime industry, including the NYK Group, participates.

Of the four demonstration vessels, Olympia Dream Seto passed the national ship inspection in December 2025 to become Japan's first certified "autonomous ship," completing preparations for commercial operation. According to research by the Nippon Foundation, this will be the world's first case of regular commercial operation on a scheduled passenger route carrying general passengers using "technology equivalent to Level 4 for self-driving," which refers to the stage at which fully autonomous operation without human intervention is partially possible in specific areas or under specific conditions. As the definitions for such levels in the context of ships are under discussion at international forums such as the IMO, the definition from the automotive field is being applied provisionally.

Olympia Dream Seto is a remote island ferry with a passenger capacity of 500 operated by Kokusai Ryobi Ferry Co., Ltd. that serves the route between Shin-Okayama Port in Okayama City and Tonosho Port on Shodoshima Island in Kagawa Prefecture. Under the MEGURI2040 project, the ferry has been used as a test ship for automation demonstrations on remote island routes. In the Seto Inland Sea, where vessel traffic is heavy and where numerous islands and rock reefs pose navigational obstacles, safety evaluations have been conducted to verify whether systems such as sensors and planners, which automatically generate collision-avoidance routes, function appropriately. In order for a vessel to operate as an autonomous ship with only onboard crew, it must undergo two inspections. The first inspection is conducted at the design stage, prior to equipment installation, aboard the vessel. Upon passing this inspection, a certificate is issued designating the vessel as an "initial-stage autonomous ship," in which human involvement is required for all tasks of the autonomous navigation system. If the vessel subsequently passes the second inspection, the vessel is permitted to operate as an autonomous ship with onboard crew only, without the presence of the developers. Olympia Dream Seto passed these two inspections in July and December 2025, respectively.

The plan is to have the remaining three vessels equipped with autonomous navigation functions under MEGURI2040 sequentially pass the required inspections and to conduct simultaneous operation of all four vessels.

Installation of an Autonomous Navigation System on a Car Carrier

NYK has begun leveraging the development achievements of MEGURI2040. With the aim of ensuring safe navigation and improving the efficiency of onboard operations, the company has decided to install the latest marine DX equipment on a car carrier that is scheduled for completion at Shin Kurushima Toyohashi Shipbuilding Co., Ltd. in March 2026. The vessel will be equipped with an autonomous navigation system developed under MEGURI2040, together with a large motion mitigation system and a Wi-Fi network covering the entire vessel. Trials will be conducted during actual commercial voyages to verify the effectiveness of these systems.

The autonomous navigation system automatically avoids collisions and groundings under crew supervision, thus supporting safe navigation. It assists with tasks during navigational watchkeeping that were previously performed manually by navigators, including information gathering, situation analysis, and collision-avoidance planning. By reducing navigators' workloads, which have increased due to vessel upsizing, rising traffic volumes, and the growing complexity of onboard equipment, the system helps prevent accidents caused by human error.

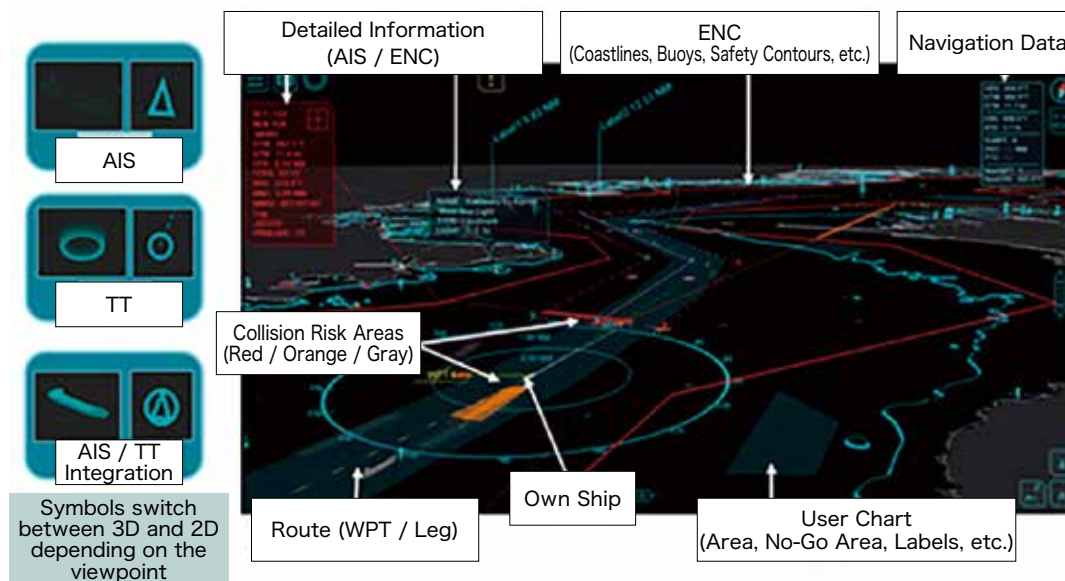
The autonomous navigation system that NYK has installed collects information from the surroundings and analyzes the situation using image recognition technology powered by AI

and automatic radar target analysis technology. In addition to visualizing information such as collision risks, the system formulates collision-avoidance plans and performs automatic maneuvering. It is also possible to immediately switch to conventional manual maneuvering performed by the crew.

The large motion mitigation system uses wave data observed by dedicated radar to simulate vessel motions based on the vessel's condition, and, based on the results, proposes to the navigator a course and speed that will minimize vessel motion. By preventing excessive motion, the system aims to protect cargo and enhance safety. Even under identical sea conditions, vessel behavior can vary significantly depending on course and speed, so digital technologies are employed to support navigational decision-making.

The vessel is also equipped with Wi-Fi access points throughout the ship, significantly improving the onboard communication environment. Although the ship-to-shore communication environment has been steadily improving with the development of satellite communications, at present, the locations where communication is possible onboard are limited to areas such as the bridge and accommodation areas. In operational areas such as the engine room, on deck, and inside cargo holds, it can be difficult to access online manuals and materials, to check the status of troubles through real-time video, and to communicate with shore-based medical institutions in the event of an injury or illness. In addition, because the hull is made of metal, in some locations, the handheld radios used for onboard communication do not function effectively, which can interfere with daily operations. Ensuring Wi-Fi access addresses such issues, enabling more efficient onboard operations and the realization of safe navigation.

Autonomous Navigation System for car carriers



Key Person Driving the Project

Serving as a Bridge and a Driving Force

Satoru Kuwahara Executive Officer, General Manager, Marine Technical Group, Japan Marine Science



— What is the significance of MEGURI2040?

Labor shortages are a social issue that also affects the shipping industry, and in particular, coastal vessels and passenger ships have already begun to suspend operations due to a lack of seafarers. In response to this social issue, the Nippon Foundation believes that fully autonomous ships are one potential solution. With the aim of maintaining the soundness of domestic logistics and passenger transportation through the social implementation of fully autonomous ships, the Nippon Foundation launched MEGURI2040, and the NYK Group is participating in this initiative. Today, we live in an era in which goods can be delivered the very next day with just a tap on a smartphone, making it easy to overlook the importance of maritime shipping in supporting domestic logistics. However, through the COVID-19 pandemic, I believe that the general public has once again come to recognize that maritime shipping disruptions have significant impacts on daily life. Given these circumstances, this project's major significance lies in realizing sustainable maritime transportation for Japan, a maritime nation.

— What are the objectives of MEGURI2040?

The first objective is to ensure transportation stability in response to the risk that a shortage of seafarers could undermine the soundness of domestic logistics. The second objective is to reduce onboard workloads as a measure to address the seafarer shortage. The third objective is to further enhance safety by providing advanced system support that accounts for human limitations, given that approximately 80% of maritime accidents are said to be caused by human error.

People tend not to look squarely at their own weaknesses. From my own experience as a seafarer, there are clear limitations to visual lookout during nighttime navigation, and as we grow older, both our eyesight and concentration gradually decline. Taking these realities fully into account, I believe we should actively incorporate technologies that compensate for human limitations. What we aim to achieve through MEGURI2040 is a system that supports safe navigation. The initial challenge given by the Nippon Foundation was the concept of achieving “completely unmanned.” While this is technically possible, social implementation is by no means easy when taking into consideration factors such as the development of rules and regulations. As an engineer, I do keep in mind the idea of a future state of being “completely

unmanned.” However, to address the social challenges right in front of us, we held extensive discussions with the Nippon Foundation within MEGURI2040 to define the goals we should realistically pursue. The system we have developed can operate vessels without onboard personnel when conditions permit, but it is not designed for fully hands-off operation 24 hours a day, 365 days a year. This design allows for human intervention in situations where traffic congestion is high and the risk of collision is significantly elevated, or when system stability declines. In other words, the concept is that the bridge is unmanned, while personnel remain on the vessel.

— How do you see crew reduction playing out in practice?

For example, a coastal cargo vessel of 749 gross tons or more is normally operated with six navigation watch personnel, consisting of two people per watch across three shifts. By replacing the role of one watchkeeper with the system, it becomes possible to operate with a three-person structure, consisting of one person per watch across three shifts. As for engine personnel, a vessel is typically crewed by a chief engineer and another engineer. By assigning the chief engineer to an FOC and providing support remotely, it becomes possible to address the labor shortage. Looking ahead, we are also working with future business models in mind, such as securing human resources by having a person with experience of seafarer work at FOCs established in various regions.

In addition, it may become possible for seafarers to hold a Class 6 license, which is an entry level qualification for coastal vessels, to operate vessels equivalent to Class 4 under system support and shore-based assistance, similar to how drivers with only an automatic transmission license can operate motor vehicles. By reducing workloads, we aim to ensure that vessels can be operated safely even with fewer people—in other words, we aim to make ships easier to operate as a means of transportation. When we talk about reducing workloads, it is easy to think only in terms of shorter working hours, but reducing the mental and psychological burdens are equally important.

— What is the NYK Group's role in MEGURI2040?

In Stage 2 of MEGURI2040, the number of participating companies has expanded to 53, and when partner companies are included, the project now involves more than 100 organizations. We are also in communication with overseas man-

ufacturers and research institutions. I serve as the project director of the MEGURI2040 consortium, overseeing the entire project, and I also act as the primary point of contact with relevant authorities and organizations such as the Ministry of Land, Infrastructure, Transport and Tourism; the Japan Coast Guard; and the All Japan Seamen's Union.

What is expected of the NYK Group, including Japan Marine Science and MTI, is our ability to accurately convey the voices of users to manufacturers. In overseas markets, where manufacturers tend to have stronger influence, the common approach is for manufacturers to promote the use of their own technologies. In contrast, Japanese manufacturers generally maintain flatter relationships with users and have a strong mindset of developing the products that users truly want. However, it is not easy to translate the on-site impressions of seafarers, such as "this feels a bit different" or "this is what we really need," into quantitative terms that manufacturers can act on. Given this situation, the NYK Group can bridge the gap by drawing on our experience as a shipping company that understands vessels and logistics operations, as well as our long history of working together with manufacturers in Japan and overseas on a wide range of technological developments.

In addition, it is extremely important to present a clear vision of the future of development to both users and manufacturers. Users can benefit from safer and more efficient operations, while manufacturers can see their technologies contributing to society and becoming viable businesses. By ensuring that all parties recognize this is a win-win relationship, companies gain confidence in the project and choose to participate. Although Stage 2 of MEGURI2040 has been extended and is scheduled to run until September 2026, NYK plans to leverage the project outcomes by installing a fully autonomous navigation system on a car carrier that is scheduled for completion in March 2026 at Shin Kurushima Toyohashi Shipbuilding, thereby further enhancing navigational safety, which is our core mission.

If you come to visit the actual project site you will be able to see, but the MEGURI2040 consortium has an atmosphere much like a high school extracurricular club, where participants freely exchange ideas while carrying out development in a lively manner regardless of their affiliation or position. Japanese culture makes it easier for people to come together in a fleet-like formation, setting aside individual interests and working collectively toward a common goal. At the same time, there is a risk that such a group can lose direction if no one takes the lead. I believe the NYK Group is expected to play that driving role to prevent the project from becoming a loosely connected gathering.

In MEGURI2040, we are making efforts not only toward technological development but toward creating the necessary environment, including rulemaking related to fully autonomous ships. Coordination with a wide range of stakeholders,



FOC designed in a sci-fi style

including the Ministry of Land, Infrastructure, Transport and Tourism, is another major role of ours. Because such an enabling environment cannot be built by the maritime cluster alone, companies from other industries, such as telecommunications providers and insurance companies, are also participating. Acting as a coordinator between the various industries is likewise an important role of ours.

— Are there any other points you would like people to pay attention to?

In MEGURI2040, we place strong emphasis on external communication. In the development and social implementation of new technologies such as these, there are two important perspectives: safety and reassurance. While technological development can enhance safety, successful social implementation also requires efforts to improve public understanding and acceptance so that people feel reassured about the safety of fully autonomous ships.

In addition, we are making efforts to ensure that MEGURI2040 attracts broad public attention in order to spark children's interest in maritime careers and to encourage system engineers, who are in high demand across many fields, to consider working in maritime-related development. For example, we hold tours for children at an FOC designed in a science-fiction-inspired style to generate a sense of excitement, and we have organized public calls for exterior design ideas for the mobile FOC, which can be seen by the public. We value a sense of playfulness as a way to engage more people and generate wider interest.

Satoru Kuwahara

Joined NYK in 1994. After accumulating experience through multiple assignments both at sea, including service on crude oil tankers, and in shore-based positions, he was seconded to Japan Marine Science in 2017. He currently serves as project director of the MEGURI2040 consortium, overseeing the entire project.



MarCoPay and Kadmos: E-Money Services for Seafarers

Supporting the Lives of Seafarers Worldwide Through a “Single Window”

An NYK Group is leveraging financial services to improve the lives of seafarers working across the world’s oceans. This company is MarCoPay Inc., which NYK set up in 2019 with its local partner, the Transnational Diversified Group (TDG), in Manila, the Philippines. The Philippines is home to the world’s largest seafarer population. A major trading house, Marubeni Corporation, and a major financial institution, MUFG Bank, Ltd., sympathized with this vision and, as a result, have jointly developed new services that support the seafarer community, leveraging their expertise. In 2025, NYK took the next step by acquiring Kadmos Holding GmbH in Germany, which provides significant payment services to seafarers of various nationalities. This collaboration has spurred a vision to build a “single window” that supports seafarers, shipowners, and crew-management and ship-management companies by linking two electronic money Issuers (EMIs).

|| Driving Growth with its Own E-Money Licenses

MarCoPay started full-scale business in 2021. The company built a platform for salary payment by using e-money (MarCoPay), setting a goal to improve the welfare of Filipino seafarers and their families. MarCoPay is the only digital salary payment platform provider for Filipino seafarers to have obtained an e-money issuer license from the Bangko Sentral ng Pilipinas, the central bank of the Philippines. Hayato Kiyohara, who has been seconded from NYK to MarCoPay, says, “The number of customers has steadily increased. There are now 60 or more businesses, including crewing companies, using MarCoPay.” Although the NYK Group uses MarCoPay, more than 90% of customers are companies not affiliated with the Group, including seafarers employed by them. Offering advantages in Philippine peso-denominated transactions, MarCoPay is becoming widely known in the Philippines as a service tailored to Filipinos.

MarCoPay has two main business objectives.

The first is to streamline the previously cumbersome salary remittance process for crew-management companies by using e-money, while also improving convenience for seafarers. Seafarers’ salaries, which are usually paid partly in cash on board, are now provided via e-money. As a result, seafarers can remit money from their smartphone app or other tools to their families, exchange their salary received in dollars for their local currency (peso) or another type of e-money, and withdraw e-money as cash at a bank or non-bank financial institution. This also relieves captains and crew-management companies of the burden of managing large amounts of cash.

The other objective is to build a maritime-industry community centered on seafarers. Although the salaries of ocean-going seafarers are high in the Philippines, their economic value is often underappreciated due to their fixed-term contracts. Some seafarers suffer inconvenience, for example, when applying for a loan. Against this background, MarCoPay

has visualized the intrinsic value of seafarers and leveraged the community’s scale to provide services such as loans and insurance at advantageous terms, as well as travel packages and favorable services for car buyers in collaboration with airlines or automakers.

|| From the Philippines to Every Nationality

In 2025, the NYK Group’s e-money business entered a new phase. In July, the Group acquired Kadmos in Germany, which globally offers a salary payment platform for seafarers. The service’s target market thus expanded from Filipino seafarers to seafarers worldwide.

The MarCoPay service is based on its Philippine e-money license and is therefore tailored to Filipinos. This is both a strength and a challenge. NYK estimates that there are roughly 2 million seafarers worldwide. Although about 300,000 to 400,000 of them are Filipinos, the main target zone that MarCoPay can directly cover includes shipowners and crew- and ship-management companies that have a high ratio of Filipino seafarers on board. The number of seafarers who work for them is only around 100,000. MarCoPay wondered how they could deliver the service to all Filipino seafarers and build services for non-Filipino seafarers as well in order to enter a larger market. The strategic solution was the acquisition of Kadmos.

By combining the services of the two companies, MarCoPay can now reach customers with a low ratio of Filipino seafarers, as well as those who employ seafarers from a wide range of nationalities, such as Indians. This is the exact complementary relationship between MarCoPay and Kadmos that was sought.

The customer base will also expand. MarCoPay already has advantages due to its existing activities in Asia, mainly with Japanese shipowners and ship-management companies. Still, its acquisition of Kadmos enables the company to

■ Company and Service Overview

	Number of users	Target seafarers	Services	Founded / Headquarters / Group Employees
MarCoPay	Over 30,000 (seafarers and their families)	Filipino seafarers	E-money services, ancillary services, such as loans and medical insurance	2019 / Manila, Philippines / approx. 100 employees
Kadmos	nearly 20,000(seafarers)	Multinational seafarers	E-money services	2021 / Berlin, Germany / approx. 20 employees

attempt service expansion to companies in maritime industry clusters in Europe, such as Greece, Germany, and northern Europe.

In October 2025, Kadmos secured a U.K. e-money license. Previously, the company had provided financial services through partner companies, but it faced restrictions on service offerings, long money transfer times, and high remittance fees. The company is expected to solve these problems by developing services under its own license.

“We want to build a framework for customers to receive services from Kadmos and MarCoPay through a single point of contact,” says Yutaka Kobayashi, who is seconded from NYK to KDMS Payments Ltd. (part of the Kadmos Holding GmbH group) in the U.K., which acquired the license. “We plan to start providing services based on Kadmos’s U.K. license for external customers around September 2026, after conducting tests with a ship-management company in the NYK Group.”

The company envisions a future system in which customers can select the service of either company according to nationality composition, using Kadmos, which covers seafarers from a wide range of nationalities, as the single point of contact for customer contracts. MarCoPay has confi-



dently provided services to Filipino seafarers, but has found it difficult to use them on ships with multinational seafarers. The Kadmos services will enable the provision of appropriate remittance services for seafarers of all nationalities. This collaboration will create significant value,” says Kiyohara.

The initiatives of MarCoPay and Kadmos are also intended to promote the wellbeing of seafarers, who play a critical role in supporting the maritime industry. Now is the time when everybody uses cashless transactions, and the number of digital native seafarers is increasing. MarCoPay is endeavoring to deliver one-stop seamless services as soon as possible.

Key Figures Driving the Project

Taking on the Next Challenge

Hayato Kiyohara President CEO, MarCoPay Inc.
Yutaka Kobayashi Director, KDMS Payments Ltd



— What led you to join NYK, and what responsibilities have you held so far?

Kobayashi: I joined NYK in 2007. I wanted to work for a shipping company because I felt that maritime transportation is an industry that supports the world. After entering NYK, I worked for the Harbour Group, U.S. Car Carrier Group, and NYK Business Systems. Then, I got involved in the Ship Business Group’s acquisition of Kadmos. Since October 2025, I have been seconded to KDMS Payments, which acquired an e-money license in the U.K. I do not feel perplexed by my new role, as we experience frequent job rotations at NYK,

and the shipping industry offers a wide range of work. The maritime transportation industry functions thanks to a variety of stakeholders, including not only customers across many industries but also shipyards, marine equipment manufacturers, seafarers, and ship-management companies that support navigation.

Kiyohara: After working for a bank from 2001, I entered NYK in 2004 through mid-career recruitment. I have spent half of my career at NYK, working on many project-planning roles in the dry-bulk field. I first worked in operations, chartering, and sales in the Forest Products Group, and later oversaw company-wide budget management and other roles in the

Corporate Planning Group. After that, I attended a business school in the U.S. for two years to learn corporate strategy and business management. After returning to Japan, I was in charge of investment management for the LNG Group and fleet expansion for the Iron Ore & Coal Group and the Dry Bulk & Energy Business Co-ordination Group. My most recent project was to build a new ship that will succeed Lady Crystal, a restaurant cruise ship in Tokyo Bay operated by our Group. Since October 2025, I have worked for MarCoPay in Manila. I want to leverage my finance background, experience gained from interacting with shipowners and ship-management companies in the dry-bulk field, and insights from project planning and overseas study in my current work.

— What drives your enthusiasm for being involved in the e-money business for seafarers?

Kobayashi: Although Kadmos's services target the niche field of seafarers' salaries, I can dive deep into the shipping industry. I also see a significant opportunity to gain finance experience while working for a ship operator. Although other companies also work on initiatives such as digital banks, many collaborate with financial institutions. It is rare for a company like ours to operate a financial business using its own e-money license. Although the current license does not cover deposits and financing, we have an eye to taking them on as the next step once the e-money business steadily matures. Since a huge amount of funding, such as charter, fuel, and other fees, is mobilized in the maritime transportation business, I envisage NYK being involved in the digital banking business in the future.

Kiyohara: As MarCoPay has established a business base, NYK's

e-money business is about to enter the next stage of development. I find this phase incredibly challenging and interesting, although we are also assuming great responsibility.

— What is your message to those who want to become navigation officers and engineers?

Kobayashi: As you are expected to act according to manuals and rules onboard, you might feel that you cannot fully express your originality. However, the range of opportunities, both onboard and ashore, is sure to expand if you first properly learn the rules and accumulate experience. Indeed, we have entered fields we had never considered before, such as offshore wind power generation and e-money businesses, over the past decade or so. In these fields, we can take on challenges such as pushing the boundaries of the rules and participating in rule-making as well. I am sure that a background in rule-based onboard experience will be useful in problem-solving in an era without clear rules, such as decarbonization initiatives. As overseas ship-management companies often manage navigation officers and engineers, I sometimes wish I could join in the conversation about topics specific to sailors.

Kiyohara: One of the things I want to share is that the field in which seafarers, navigation officers, and engineers can thrive is expanding. For example, the manager of the e-money business team at NYK is a former in-house-trained seafarer. Navigation officers and engineers not only operate vessels but also engage in a wide range of activities, including new business development and corporate acquisitions.

Second, their activity arena has spread worldwide. For example, many people who have served as captain or chief engineer, even at other companies, work in the Philippines, a country that is an important source of seafarers.

Third, an environment has been established where you can receive various kinds of support. The business purpose of Kadmos and MarCoPay is to improve seafarers' quality of life and create an environment where they can focus on their work. And the number of shipowners, crew-management, and ship-management companies that use our services and understand their value is increasing. The maritime industry has high expectations for navigation officers and engineers, and as someone who works closely with them, I will give you as much support as possible.



From left: Hayato Kiyohara, Toshiaki Fujioka who led MarCoPay since its founding, and Yutaka Kobayashi



Development and Full-scale Deployment of an AI-based Vessel Allocation System for Car Carriers

Rapid Generation of Optimal Plans, Contributing to GHG Reduction

NYK, together with its group company MTI Co., Ltd., has jointly developed and introduced a system that automates and optimizes vessel allocation planning for car carriers in collaboration with GRID Inc. (Minato-ku, Tokyo; CEO: Masaru Sogabe), a provider of planning optimization solutions that utilize AI technology. Full-scale operation of the system began in July 2025. The system uses AI to evaluate several million possible combinations of vessel allocation plans covering several months ahead and to derive optimal solutions in approximately 10 minutes. In addition to optimizing vessel utilization, transportation efficiency, and transportation costs, the system is expected to help reduce greenhouse gas (GHG) emissions.

Addressing Challenges as a Team

Vessel allocation planning for car carriers is a critically important task that determines from which loading ports to which discharge ports, when, by which vessels, and in what volumes cargo is to be transported. After sales representatives ascertain inventory levels and request delivery dates at each customer location and organize transportation requirements, they formulate plans aimed at minimizing costs or maximizing profits while considering a wide range of constraints, including vessel transport capacity, port arrival and departure schedules, cargo handling schedules, dry-docking, bunkering, and charter contracts. In recent years, factors such as sailing at optimal speeds to reduce GHG emissions have been added, further increasing the complexity of vessel allocation planning. In addition, plans must be reviewed and adjusted on an ongoing basis to address sailing delays, operational issues, and changes in cargo schedules.

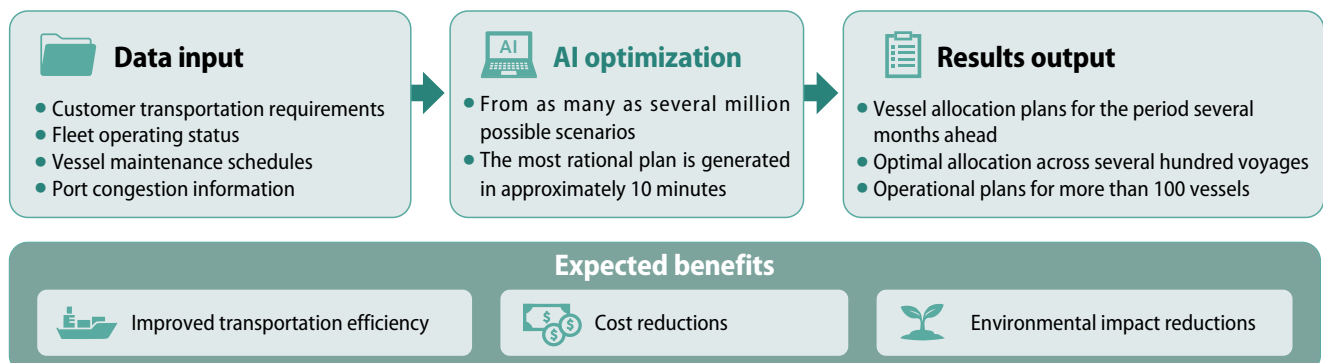
NYK operates about 120 car carriers globally, the largest fleet in the world, and has conventionally relied on a limited number of highly experienced personnel to prepare vessel



From left: Hiroyuki Nozaki (DX&BPM Team) and Naoki Motohashi (Coordination Team), Automotive Business Management Group, NYK; Narihiro Mitsushima (Researcher, Ship System Team) and Yoshihiko Maeda (Deputy General Manager), Maritime & Logistics Technology Group, MTI.

allocation plans that cover several hundred voyages months in advance. Due to the nature of this work, the vessel allocation planning process has been highly dependent on individual expertise, making efficiency improvements and knowledge transfer significant challenges.

Flow of Vessel Allocation Optimization



Against this backdrop, NYK began developing an AI-based vessel allocation system in 2021 to organize and structure the information and decision-making factors involved in car carrier allocation operations, thereby improving planning accuracy and efficiency. The project involved vessel allocation planners, the DX-BPM Team from the Automotive Business Management Group, and engineers from MTI with expertise in mathematical optimization. GRID was selected as the system development partner from among multiple candidates. Hiroyuki Nozaki of the DX-BPM Team recalls the reason for deciding to move forward with development with GRID, saying, "What proved decisive was their attitude of not merely promoting their own systems or technologies, but of sincerely engaging with and seeking to understand our business operations and the challenges that we face. Throughout the actual development process, they responded flexibly, proactively, and sincerely."

Deputy General Manager Yoshihiko Maeda, Maritime & Logistics Technology Group, MTI, emphasizes that "In developing the system, it was significant that the DX-BPM Team first carefully organized and structured the decision-making factors involved in vessel allocation operations." He continues, "While AI's computational capabilities tend to draw attention, what is fundamentally important is that there is a process of collecting high-quality data from within the company and that the mechanism for visualizing optimization results in a form that vessel allocation planners can understand and use for decision-making." As to why development of a vessel allocation system was pursued for car carriers first, he notes that "while factors such as high fuel consumption and a large fleet size played a role, even more important was that the information and working processes related to vessel allocation in our car carrier division had already been well organized." Meanwhile, Nozaki describes MTI's role in the project as, "DX-BPM Team had no prior experience in AI development, and we found it challenging to assess the validity of the technical approaches and development methods proposed by the development team. We also struggled to determine what information they truly needed and how best to organize and communicate our requirements in an easily understandable way. Given this situation, the fact that Maeda and Mitsushima from MTI, who possess deep expertise in mathematical optimization, worked closely alongside us in both the technical aspects and in organizing requirements was critically important in moving the project forward."

|| Taking on the Challenge of Business Transformation

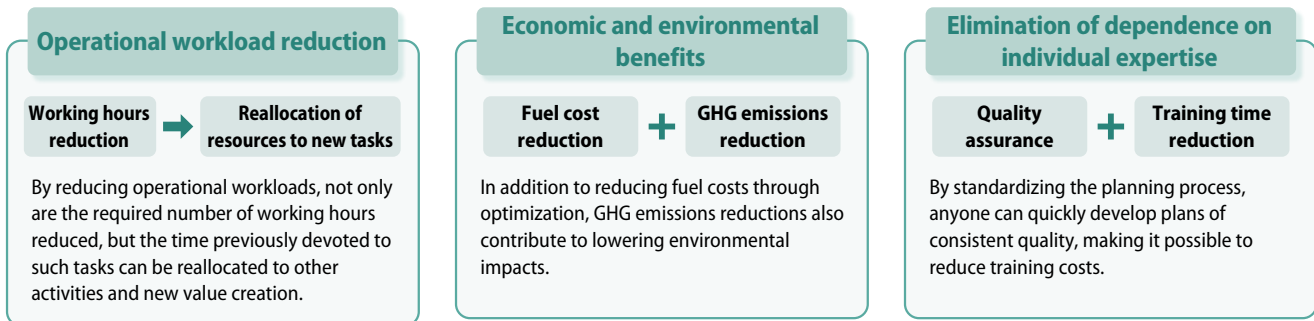
Naoki Motohashi, who is responsible for vessel allocation operations in the Automotive Business Management Group, evaluates the effects of introducing the AI-based vessel allocation system, stating that "In addition to improving

operational efficiency, the system has made it easier to avoid human error, such as overlooking important conditions, including dry-docking schedules or redelivery points at the end of charter contracts." He also notes that the system's flexibility in incorporating changes in the external environment, such as port fees imposed by the Office of the United States Trade Representative (USTR) or EU GHG emissions regulations, is a significant advantage. He adds, "Previously, whenever something happened, we had to repeatedly rework plans through trial and error in Excel. Now, we can simply change the conditions and recalculate with the push of a button, which has significantly reduced the burden in our day-to-day operations. The amount of overtime during peak periods has also decreased." Furthermore, "With AI supporting the planning process, it has become easier for other personnel to step in even if I am unexpectedly absent. This also has significant implications from a business continuity planning (BCP) perspective."

Explaining the background behind the four-year period required to reach full-scale deployment, Nozaki states, "If the scope had been limited to developing the optimization engine alone, it might have been delivered in a much shorter timeframe. However, AI-generated vessel allocation plans become truly practicable when combined with mechanisms that enable human operator to evaluate and adjust them. In addition, it was critically important to build not only the system itself but also the associated working processes, including data input such as the vessel movement information required for vessel allocation. Developing a UI/UX system that met these requirements demanded particularly complex functionality and highly accurate data management, necessitating a time-consuming development process." He reflects, "Throughout the long development period, I was deeply grateful to the colleagues in vessel allocation, sales, and operations, who made the time to support the project while fulfilling their daily responsibilities."

While there appeared to be some internal hesitation and anxiety about significantly changing long-established ways of working, Nozaki explains, "At the time, while we recognized that there was room for improvement in vessel allocation operations, the work lay at the very core of the car carrier business. Moreover, we viewed it as an area in which it was challenging to build internal understanding, not only regarding the introduction of AI, which was not yet widely adopted, but also regarding systemization in and of itself. Nevertheless, what enabled us to move the initiative forward was the culture within the Automotive Business Headquarters that encouraged operational improvement and tackling new challenges, together with the strong sense of crisis and determination among vessel allocation planners at the time that continuing with the same approach would leave us without a future."

■ Expected Benefits of Vessel Allocation Optimization



■ Software Measures Effective in Reducing GHG Emissions

Regarding future developments, Nozaki states, “In addition to continuing to refine the system by operating it with car carriers, in the future we also want to take on the challenge of achieving integrated optimization that encompasses fleet capacity management and associated operations.”

Maeda points out that “In efforts to reduce GHG emissions, software-based approaches are extremely effective.” In addition to optimizing vessel allocation, NYK and MTI are working on initiatives such as slow steaming enabled by shorter cargo handling times and reducing GHG emissions per unit of transport through improved loading efficiency. He adds, “While hardware measures such as the installation of

energy-saving devices, wind-assisted propulsion system, and fuel shift tend to attract attention, software has significant potential when considering both costs and emissions reduction effectiveness.”

Moreover, it has been noted that the use of AI has led to an increase in collaborations, such as this one, between companies and research institutions in the maritime industry. Maeda explains, “At MTI as well, not only personnel with traditional naval architecture backgrounds but an increasing number of people, me included, who have studied computer science and mathematics are joining the organization. The crossover of expertise between shipbuilding and IT engineers is leading to the creation of new value,” expressing his expectations for further advances in technological development through new collaborations.





Pioneering the Future of Ship Design with 3D Models

Digitalization Also Contributes to Greater Efficiency in Ship Management

In recent years, efforts toward digital transformation (DX) in the maritime industry have progressed. However, when viewed across the entire vessel life cycle, from design and construction to operation, there remains substantial room to incorporate digital transformation and further digitalization. Much of ship design still relies on 2D drawings, which require significant time to align understanding among stakeholders, including shipyards and shipping companies. In addition, the design documents after vessel completion are often provided as PDF files, making them difficult to utilize effectively as digital data. In response to these challenges, the NYK Group has been advancing the Ship Design Streamlining Project, led by MTI Co., Ltd., which has an R&D function, in collaboration with shipyards, design firms, and a classification society.

Reducing the Burden of Design Work

Under the Ship Design Streamlining Project launched in 2021, a system has been introduced that stores information such as vessel specifications and general arrangement drawings in a database and then converts it into 3D models for use. Design is advanced using a “front-loading” approach, and after a vessel enters service, digital finished plans are utilized to further evolve both vessel design and ship management.

Ship design proceeds in stages: development and planning, basic design, detailed design, production design, and finally, construction. “Front-loading” refers to advancing the peak of cost and resource allocation in this timeline and making critical decisions at the earliest possible stage. In conventional shipbuilding processes, the peak workload typically occurs during the middle to later phases, particularly during detailed design and production, and design changes made in these stages are likely to lead to increased costs and extended construction schedules. If design changes in the later phases can be reduced, overall productivity can be improved.

The key to front-loading is the use of 3D models. By using 3D models from the early stages, the vessel’s final form can be visualized, and layouts and specifications can be examined while confirming them visually. This reduces the need to revisit earlier steps in the process. In addition, by reviewing

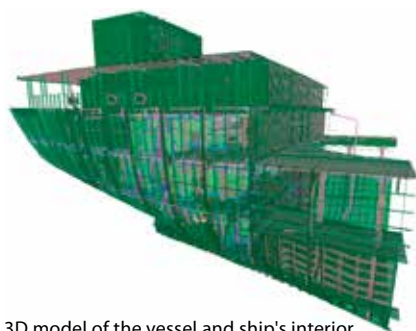
the process itself, it becomes possible not only to lower the peak of resource allocation but to reduce the overall workload.

While shipyards have been introducing 3D CAD systems, these have largely remained tools for internal design work. What is innovative about the NYK initiative is the use of 3D models as communication tools among stakeholders. Such use facilitates faster decision-making and smoother collaborative design. Complex layouts and structures that are difficult to understand from 2D drawings can be grasped intuitively through 3D visualization. This also allows far-away participants to connect via the internet and to hold discussions while viewing the same model.

General Manager Hidehiko Sato of the Ship Business Group at NYK explains, “3D models can be understood intuitively at a glance, so they are also useful as tools for marketing to customers. Shipyards can use them when explaining designs to shipowners, and shipowners can use them when explaining vessels to shippers.” Sato has been involved in this project since he was seconded to MTI.

Building vessels based on 3D designs also enables leveraging accumulated data to develop digital tools that can be used for maintenance planning and maintenance history management, and these tools can be applied to future new-building projects.

In 2024, a trial was conducted to apply 3D models in



3D model of the vessel and ship's interior



the initial design stage of vessel construction. In this trial, the NYK Group collaborated with Smert Design Co., Ltd., which engages in vessel design and system development using 3D CAD, and carried out a demonstration to design an LPG carrier for Kyoei Tanker Co., Ltd.. The vessel was built by Murakami Hide Shipbuilding Co., Ltd. and completed in September 2025. 3D models were created from the early stages of design and were used for specification reviews, decision-making, and the approval of drawings for detailed design.

This demonstration primarily used paper drawings, with 3D models employed in a supplementary role. As a result, the quantitative effects, such as reductions in working time, were limited. However, feedback from on-site personnel clearly indicated that “viewing unclear areas in 3D improves understanding,” raising expectations for broader adoption of 3D utilization in the future.

Utilizing “Digital Finished Plans” After Entry into Service

3D models also allow digital finished plans to be used for ship management after a vessel has been built. Various documents (including general arrangement drawings, system diagrams, and manuals) are integrated based on data created through 3D design. By simply clicking on equipment or piping within the 3D model, users can immediately access the relevant materials for that specific section. Previously, it was necessary to search for documents each time in storage rooms or digital folders, but digital finished plans significantly reduce the effort required. In addition to linking finished plans provided by shipyards, it is possible to jump from 2D drawings to the corresponding 3D locations, measure dimensions by moving the cursor, and insert comments about defects or repair records. These functions provide sub-

Initiatives for Utilizing 3D Models in the Ship Design Streamlining Project

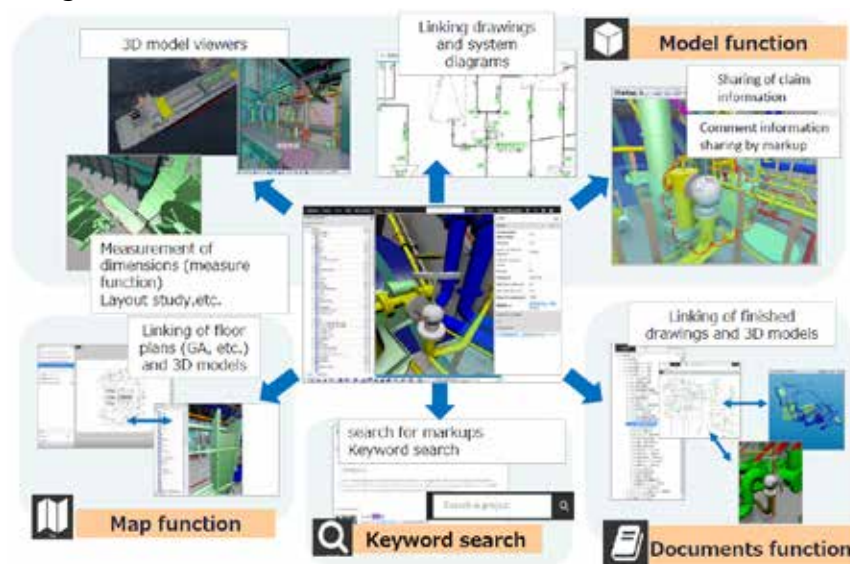
Phase 1 (May 2021 to November 2021)	Analysis of the content of discussions between shipbuilding companies and shipping companies, analysis of approval drawings, analysis of specifications, and concept development for 3D model utilization tools
Phase 2 (January 2022 to October 2022)	Detailed development of the concept of 3D model utilization tools and concept development of digital finished plans based on 3D CAD design
Phase 3 (November 2022 to July 2023)	Efforts toward practical operation of 3D model utilization tools and trial use of digital finished plans
Phase 4 (August 2023 to April 2024)	Practical operation trials of 3D model utilization tools and productization of digital finished plans
Phase 5 (May 2024 to December 2024)	Verification of trial results for 3D model utilization tools, development of information-sharing tools for digital finished plans, and verification of design approval processes using 3D models

stantial practical benefits for seafarers and ship management supervisors.

Ideally, 3D models should be used from the vessel design stage and continued to be used after completion. However, it is also true that it is not easy to fundamentally change long-established practices at the shipyards responsible for design. Therefore, NYK has adopted a strategy of promoting the use of digital finished plans for after vessel completion—in other words, in the downstream phase of the life cycle—to demonstrate value enhancement. Based on this, the company aims to eventually extend adoption to the upstream phase, namely the early design stage.

Trials of actual vessels are also underway in preparation

Digital Finishes Plan



for the commercialization of Smert Design's digital finished plans. Asia Pacific Marine Corporation, a coastal shipping company, is using an alpha version of digital finished plans for two coal carriers in its vessel management operations. Sato stated, "Digital finished plans have been highly evaluated for their ease of use, and we hear that they are easy to use not only as a ship-to-shore communication tool but for explaining matters to cement companies, which are the shippers." Digital finished plans are also being actively used for Kyoei Tanker's LPG carrier mentioned above.

As the next project, initiatives are underway to use 3D laser scanning to create 3D models of existing vessels without 3D data. The vessel interior is scanned to generate point cloud data, which is then processed into a 3D model. By linking this model to existing drawings and documents, it is possible to independently generate digital finished plans.

Integration with existing ship management systems gives digital finished plans further development potential. In the initiative with Asia Pacific Marine, linking digital finished plans with the vessel maintenance management system the company already operates enables maintenance reports to be associated with 3D models, allowing users to visually identify which equipment and parts of that equipment the

work relates to. Sato stated, "We believe that digital finished plans can be made even more user-friendly by adapting them to the existing systems of each ship-management company."

Looking further ahead, there is the potential for utilization at fleet operation centers (FOC) for autonomous vessels. If the actual layout and condition of equipment can be checked in 3D, operational management scenarios in which a shore-based chief engineer at an FOC provides instructions to onboard engineers will become increasingly realistic.

With a view to improving the efficiency of ship design through the use of 3D models and expanding their utilization after completion, Sato emphasizes, "From the perspective of a shipping company, we want to develop tools that stay close to the work of designers." He also stresses that, for these initiatives to become industry standards, it is important that the new tools be universal rather than tailored to individual companies. Concept development should be part of the cooperative domain, while tool development and utilization under new concepts should be part of the competitive domain. Initiatives in which vessel builders and vessel users work together are steadily progressing.

Key Person Driving the Project

The Appeal of Developing and Marketing One's Own Creations

Hidehiko Sato General Manager, Ship Business Group



— You have been working on the 3D model utilization project. How do you feel about the progress so far?

I have been involved in work across the entire vessel life cycle, from completion through to operation, including responsibilities for newbuilding technology and ship management. My sense of the issues regarding newbuilding design developed during my time as a technical manager for newbuildings and became a research theme when I was seconded to MTI. Once we got started, the response from those around us was positive. At the same time, there were also comments about hurdles in the actual implementation. Since this initiative involves changing conventional processes, such a reaction is understandable. Even so, thanks to the people who have viewed the initiative favorably, we have been able to continue this effort over the long term.

— After being involved in research on 3D models, you are now in a sales position in which you introduce the NYK Group's technologies to external parties.

I find it interesting to market something I developed myself, and I feel I am in the right position at the right time.

— What is your message to those who aspire to become engineers?

One attractive aspect is that you can engage in work with a broad scope. Within engineering, there are many different fields. It is easy to become confined to a single area, such as marine engineering or technical management, but there are opportunities to take on work that goes beyond these boundaries, including R&D and technical sales. I feel that the stages in which engineers are involved are gradually expanding. I would like people not to become overly focused on their own specialties, but to boldly take on new roles from a broad perspective. Of course, becoming involved in fields you did not originally imagine may present hurdles, but this can also create new opportunities. By accepting such challenges with an open and flexible mindset, you may be able to see new directions for your own growth.



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