Research on the Reform of Talent Training System for Maritime Technology Major Oriented to Intelligent Shipping

Hongwu Wang
Hubei Communications Technical College, Wuhan, Hubei, China

Abstract: The shipping industry is undergoing a profound transformation centered on green development, low-carbonization, and intellectualization. Aiming at core problems such as the disconnection between traditional training models and cutting-edge industrial demands, as well as the mismatch between students' diversified development needs and single rigid training programs, this study systematically analyzes the global development trend of intelligent shipping and comprehensively reviews the current situation of domestic maritime education. Drawing on advanced experience in classified talent training and deep integration of industry and education from world-class universities, it proposes a systematic reform path. The study points out that the transformation and development of the maritime technology major must firmly anchor on the direction of "intelligentization, digitalization, and integration", with the core being to construct a new talent training system aimed at cultivating "intelligent decision-making ability" and "cross-border integration literacy". Key reform measures include reconstructing "intelligence +" curriculum modules, innovating a stepped practical teaching model of "virtual-real integration", and deepening the collaborative education mechanism of "school-enterprise dual subjects".

Keywords: Intelligent Shipping; Maritime Technology; Talent Training; Industry-Education Integration; Curriculum System; Teaching Reform Introduction

1. Introduction

As a foundational engineering discipline supporting the development of global trade and economy, the quality of talent training in maritime technology is directly tied to a country's shipping competitiveness and maritime safety assurance capacity. At present, a new generation of information technologies represented by artificial intelligence, big data and the Internet of Things are deeply integrated with the shipping industry, driving a systemic transformation encompassing ship design, navigation control, port operation and energy systems [1]. The popularization rate of intelligent ships is growing at an annual average rate of 15.6%, and the port automation rate has exceeded 40%, which puts forward brand-new requirements for the knowledge structure and competency of maritime professionals [2]. The goal of achieving net-zero emissions in the shipping industry around 2050 proposed by the International Maritime Organization (IMO) has further accelerated this industrial revolution characterized by "green development, low carbonization and intelligentization" [3,4]. Against this backdrop, the core functions of ships such as perception, cognition, decision-making and control are gradually shifting from crew members to intelligent systems, and the traditional role of "operation-executing" seafarers is evolving into that of compound talents with expertise in "monitoring and decision-making" and "system operation and maintenance" [5].

However, China's maritime technology education is still confronted with prominent challenges in coping with this unprecedented transformation. On the one hand, there exists a certain degree of misalignment and lag between the orientation of talent training goals, curriculum content and the rapidly evolving industrial technologies [6]. On the other hand, the existing teaching resources and practical training models fail to match the requirements for cultivating interdisciplinary knowledge and digital skills essential for intelligent shipping [7]. Although some universities have launched reform pilots, a systematic and scalable solution has not yet been developed. Therefore, exploring and constructing a new talent training system for the maritime technology major that adapts to the demands of the intelligent shipping era has become an urgent and pivotal task. Through forward-looking system design and multi-dimensional guarantee measures, maritime education can effectively support the development of new quality productive forces in the shipping industry. Graduates' intelligent technology application ability has increased by 37.2%, and post adaptability has improved by 41.5%, laying a solid talent foundation for China's strategic transformation from a major shipping country to a global maritime power [8]. This study aims to conduct an in-depth analysis of the technological and industrial development trends of intelligent shipping, diagnose the key shortcomings of current maritime education, and based on advanced practices at home and abroad, put forward a comprehensive reform framework covering goal reshaping, curriculum reconstruction, practical innovation and mechanism guarantee, so as to provide theoretical reference and practical guidance for the transformation, upgrading and high-quality development of the maritime technology major.

2. Development Trends of Intelligent Shipping and Changes in Talent Demand

The transformation of the global shipping industry is not a breakthrough of a single technology, but an ecological reshaping of the entire industrial chain driven by multiple forces. Understanding the connotation and characteristics of this trend serves as the logical starting point for the forward-looking design of the talent training system.

2.1 Technology-Driven Profound Transformation of the Shipping Industry

The development of intelligent shipping exhibits a distinct characteristic of moving from "ingle-point breakthroughs" to "system integration" and "ecological coordisnation". At the ship level, intelligent navigation technology has become the focal point of international maritime technological competition. China has successfully developed an integrated intelligent navigation system integrating assisted navigation, remote control navigation and autonomous navigation, and realized its commercial operation on vessels such as the "MV Zhifei". The accuracy of its intelligent perception has reached 99.2%, keeping pace with the international advanced level. This marks the evolution of ships from traditional means of transportation to large-scale intelligent mobile terminals. At the port and infrastructure level, revolutionary practices represented by the "Zero-Carbon Terminal" of Tianjin Port have demonstrated the feasibility of achieving carbon neutrality throughout the entire production process through the "integration of wind, solar, energy storage and load" smart energy system. Meanwhile, the application of automated quay cranes, unmanned container trucks, intelligent yards and other facilities has greatly improved operational efficiency [1]. At the system level, the concept of the "New Generation Shipping System" proposed by Academician Yan Xinping is promoting the construction of a new waterway transportation system featuring in-depth coordination of the "ship-port-cargo-people-machine-environment" ecosystem, which is underpinned by big data, the Internet of Things and artificial intelligence [5]. This systemic transformation implies that future shipping management will be based on digital models and real-time coordination covering all elements and the entire process.

2.2 New Industrial Transformation Requirements for Core Competencies of Maritime Talents

The profound industrial transformation has directly reshaped the competency profile required of maritime talents. Traditional maritime education focuses on cultivating operational seafarers who meet the requirements of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention), with an emphasis on practical skills such as ship maneuvering, collision avoidance and cargo transportation. Under the background of intelligent shipping, the demand for maritime talents has undergone fundamental changes: First and foremost, "intelligent decision-making and system management capabilities" have become the core competencies. Seafarers are required to understand, monitor and intervene in the decision-making process of intelligent navigation systems, and conduct effective take-over and advanced decision-making in complex sea conditions or in the event of system abnormalities [9]. This means that they must not only possess professional maritime knowledge, but also have a solid foundation in data analysis and artificial intelligence algorithms. Second, "interdisciplinary knowledge integration capability" is becoming increasingly vital. Green shipping involves the application of alternative fuels such as methanol, ammonia and hydrogen, as well as emerging technologies including carbon capture and wind-assisted propulsion [3,4]. This requires maritime talents to master not only ship power system knowledge, but also relevant fields such as new energy technology and environmental engineering. Third, "ship-shore coordination and remote support capabilities" have become indispensable. With the enhancement of ship-shore communication bandwidth and the establishment of data centers, some functions such as ship management, fault diagnosis and route optimization will be transferred to shore-based support centers [4]. Seafarers need to collaborate efficiently with shore-based engineers to address navigation and ship management issues jointly. Finally, "lifelong learning and innovative adaptation capabilities" are the key to sustainable development. Shipping technology will continue to evolve at a rapid pace, and practitioners must be able to continuously learn new technologies, new norms and new business models to adapt to the dynamic development of the industry [6]. These new demands all converge on a single goal: cultivating compound and innovative high-end talents who can operate intelligent ships and integrate into the new shipping ecosystem.

3. Current Status and Major Challenges of Talent Training for Maritime Technology Major

Faced with the clear and urgent new demands, a review of the current status of China's maritime technology education reveals several structural challenges in its ability to respond rapidly to industrial transformation.

3.1 Lag in the Curriculum System and Teaching Content

At present, the core curriculum system of most maritime universities is still built around traditional ship navigation and management skills, such as <<Maritime Navigation>>, <<Ship Maneuvering>> and <<Ship Collision Avoidance>> etc. Although these courses are indispensable, modules covering cutting-edge content [7]. Such as intelligent navigation, autonomous collision avoidance decision-making and shipping big data analysis are generally absent or only briefly introduced. For instance, the key technical principles of intelligent ships, including perception fusion, path planning and digital twin, have not been systematically integrated into undergraduate teaching syllabi. The slow update of teaching materials is also a prominent issue. Only recently have textbooks such as Introduction to the New Generation Shipping System that systematically introduce intelligent shipping emerged, filling the gap in this field [5]. The lag in curriculum content leads to a "knowledge gap" between what graduates have learned and the actual application in the industry, making it difficult for them to quickly take up positions on intelligent ships.

3.2 Disconnection between the Practical Teaching System and the Application of Cutting-Edge Technologies

Maritime technology is a discipline highly dependent on practical training, yet traditional practical teaching suffers from two major disconnections. First, the disconnection from advanced equipment. On-campus training mostly relies on traditional simulators for marine engineering, steering gear and navigation instruments, while training conditions for cutting-edge equipment such as intelligent ship control systems, ship-shore collaborative operation platforms and new energy power systems are severely inadequate [7]. Second, the disconnection from real working scenarios. Although students are arranged to board ships for internships, the operation mode of traditional ships cannot provide opportunities to access new scenarios such as intelligent navigation and big data platforms for energy efficiency management [10]. Although virtual simulation technology has been introduced to simulate complex sea conditions [9], most of the simulated objects and processes still follow traditional shipping models, failing to fully construct decision-making and emergency response scenarios for intelligent shipping. This disconnection leaves students' practical skills stuck in the past, preventing them from developing the core practical and cognitive abilities required to operate future intelligent shipping systems.

3.3 Urgency of Transforming the Knowledge Structure of the Teaching Staff

Teachers are the key implementers of teaching reform. At present, a large number of teachers in the maritime technology major have rich ocean-going navigation experience, which is an invaluable asset. However, intelligent and green shipping involves a wealth of emerging interdisciplinary knowledge, and many teachers themselves are in the process of learning and transformation. It is quite challenging for teachers with a traditional maritime background to teach courses such as artificial intelligence algorithms, big data analysis and new energy technologies [7]. Meanwhile, it is not easy to recruit double-qualified talents who possess both expertise in intelligent technologies and practical maritime experience from enterprises. If the transformation of the knowledge structure of the teaching staff is not accelerated, the design of all curriculum and teaching reforms will be difficult to implement in practice.

3.4 Contradiction between the Monolithic Talent Training Model and the Diversified Development Needs of Students

For a long time, the training programs for the maritime technology major have shown a strong tendency of homogenization, aiming at mass-producing seafarers who meet the standards of international conventions [6]. However, in the era of intelligent shipping, the industrial chain has been extended and subdivided, giving rise to diversified job demands: there is a need for senior seafarers working on intelligent ships, technical engineers engaged in monitoring, operation and maintenance, and data analysis at shore-based support centers, innovative talents involved in research and development and testing at shipping technology companies, as well as management talents responsible for formulating regulations and standards for intelligent shipping at maritime administrative institutions [6]. The monolithic training model cannot meet the needs of students' personalized development and the diversified job positions in the industry, leading to a structural mismatch between talent supply and market demand.

4. Advanced Experience and Enlightenments of Maritime Education Reform at Home and Abroad

To address the above challenges, some leading maritime universities at home and abroad have carried out enlightening reform explorations, providing an important reference for this study to construct a reform pathway.

4.1 Innovation of Student-Centered Classified Talent Training Models

The reform practice of the Navigation College of Jimei University is highly representative. Breaking the traditional “one-size-fits-all” model, the university has pioneered a classified training system featuring an “Elite Class”, an “Excellence Class” and an “Intelligent Maritime Class” in China, in accordance with the subdivided demands of the industry and students' interests and aspirations [6]. The “Elite Class” focuses on cultivating management literacy, nurturing future leaders for maritime-related administrative departments such as maritime affairs and port authorities; the “Excellence Class” strengthens practical skills, relying on in-depth school-enterprise cooperation to cultivate application-oriented backbones who can immediately be competent for positions in shipping enterprises; the “Intelligent Maritime Class” emphasizes innovative thinking and cutting-edge technologies, fostering R&D-oriented talents for scientific research institutes and technology companies [6]. This model of “teaching students in accordance with their aptitude and providing classified talent supply” effectively resolves the contradiction between the homogenization of talent training and the diversification of industrial demand, and realizes the alignment between students' personalized growth and the precise talent needs of the industry.

4.2 In-Depth Industry-Education Integration and School-Enterprise Collaborative Education Mechanism

Deepening school-enterprise cooperation is the key to enhancing the pertinence of talent training. The Department of Intelligent Maritime Engineering of Chongqing Jiaotong University proposed the establishment of a “school-enterprise dual supervisor system”, inviting technical backbones from enterprises to participate in the revision of training programs and curriculum teaching [7]. Jimei University has taken this mechanism a step further, signing joint training agreements with 25 well-known shipping enterprises and designing a “3+1” academic system for students of the “Excellence Class”: three years of on-campus study and the fourth year of full-time enterprise training, under the joint guidance of “on-campus captains + enterprise captains”, with a one-year on-board internship and post training to achieve the goal of “employment upon graduation and competence upon taking office” [6]. This in-depth, integrated and whole-process collaborative education mechanism ensures the seamless connection between teaching content and industrial practice.

4.3 Empowering the Teaching and Learning Process with Artificial Intelligence Technology

Utilizing artificial intelligence technology not only as teaching content but also as a teaching tool is reshaping the form of education and teaching. Chongqing Jiaotong University has explored a dual-track teaching model of “AI + Teacher”, where AI is used to undertake tasks such as knowledge graph construction, virtual simulation training, personalized learning data analysis and feedback, enabling teachers to focus more on value guidance, innovative thinking inspiration and personalized guidance on complex problems [9]. For example, through dynamic virtual simulation of decision-making scenarios for intelligent ships under extreme weather, equipment failures and complex traffic flows, students' emergency response and collaborative disposal capabilities are cultivated [9]. This provides a new idea for breaking the bottleneck of traditional teaching methods in cultivating high-order cognitive abilities.

4.4 Strengthening Professional Identity and Whole-Process Academic Guidance

The maritime profession has its unique characteristics, so it is crucial to strengthen students' professional identity and career planning. The Shipping College of Chongqing Jiaotong University has innovated the form of academic guidance, inviting outstanding alumni to share their growth paths and professional glory from campus to ocean navigation, and organizing students to participate in immersive practical experiences, with senior captains explaining equipment operation and safety regulations on site [10]. This dual-track guidance model combining “theoretical lectures + hands-on practice” materializes long-term prospects such as career development, salary expectations and participation in national strategic projects (e.g., Arctic navigation), effectively stimulating students' internal learning motivation and professional pride, and laying a solid psychological and cognitive foundation for their long-term career development [10].

5. Reform Pathway of the Talent Training System for Maritime Technology Major Oriented to Intelligent Shipping

Based on the aforementioned trend analysis, challenge diagnosis and experience reference, this paper proposes a systematic reform framework for the talent training system of the maritime technology major. The framework takes goal reshaping as the forerunner, curriculum and practical system reconstruction as the core, and mechanism innovation as the guarantee.

5.1 Reshaping Talent Training Goals: From “Operation Executors” to “Intelligent Decision-Makers and System Managers”

First and foremost, it is imperative to fundamentally reshape the talent training goals in the top-level design. The new goals should be positioned as follows: cultivating high-quality compound maritime talents with all-round development of morality, intelligence, physical fitness, aesthetics and labor, who possess a profound sense of national pride, international vision and professional ethics, have a solid grasp of modern maritime navigation theories and intelligent shipping technologies, are proficient in intelligent ship navigation control, ship-shore collaborative operation and green energy management, and endowed with cross-border learning ability, innovative thinking and outstanding leadership. These goals make it clear that graduates should not only hold seafarer competency certificates, but also have the potential to become future “managers” and “decision-makers” of the intelligent shipping system.

5.2 Reconstructing a Modular Curriculum System with “Solid Foundation, Strong Intelligence Orientation and Emphasis on Integration”

To achieve the new goals, it is necessary to carry out “intelligent upgrading” and “integration expansion” of the existing curriculum system, and construct three major curriculum modules:

“Intelligent Maritime Core” Module: Infusing intelligent elements into traditional core maritime courses. For example, upgrading <<Maritime Navigation>> to <<Intelligent Maritime Navigation>> by adding content such as multi-source information fusion positioning, intelligent path planning and dynamic optimization; integrating autonomous collision avoidance decision-making algorithms and human-machine co-navigation interaction principles into <<Ship Maneuvering and Collision Avoidance>>; and offering new courses such as <<Shipping Big Data Analysis and Decision-making>>, <<Principles of Ship Intelligent Control Systems>> and <<Introduction to the New Generation Shipping System>> etc. [5,7].

“Green Technology Cross-border” Module: Offering courses such as <<Marine Alternative Fuel Technology and Safety>>, <<Ship Energy Efficiency Management and Carbon Emission Reduction>> and <<Marine Environmental Protection and Regulations>> etc, and setting up interdisciplinary elective courses in collaboration with faculties of energy, chemistry and environmental engineering to establish students' systematic knowledge of green shipping [3,4].

“Digital Literacy General Education” Module: Strengthening general education in digital literacy for all students, including courses such as <<Python Language and Maritime Data Analysis>>, << Internet of Things and Ship-shore Communication>> and <<Fundamentals of Artificial Intelligence>> etc, laying a solid instrumental foundation for subsequent professional learning [7].

5.3 Innovating a Three-Dimensional Practical Teaching System of "Virtual-Real Integration and Step-by-Step Progression"

The practical teaching system needs to be innovated in tandem with curriculum reform, constructing four progressive levels:

Basic Skill Virtual Simulation Training: Utilizing VR/AR technologies and advanced simulators to conduct standardized skill training such as basic safety operation, equipment operation and conventional navigation, laying a solid foundation for practical skills [9].

Intelligent System Specialized Training: Building intelligent ship control laboratories and ship-shore collaborative digital twin platforms to enable students to conduct specialized training on new skills such as intelligent navigation system monitoring, remote control operation and energy efficiency platform data analysis [7].

Comprehensive Scenario Project-based Practice: Designing cross-curriculum practical projects based on real industry scenarios, such as "Full-task Simulation of Intelligent Transoceanic Navigation of a Container Ship", where students work in teams to complete the entire process from intelligent route planning, new energy configuration and on-the-way monitoring to emergency response, cultivating their systematic thinking and team collaboration capabilities [9].

Industrial On-site Immersive Internship: Establishing new internship bases in cooperation with cutting-edge enterprises such as intelligent ship operation companies, green fuel bunkering ports and shore-based support centers, allowing students to engage in on-the-job internships or research projects in the forefront of the shipping industry [6,10].

5.4 Deepening the Industry-Education Integration Education Mechanism of “Multi-Stakeholder Collaboration and Dynamic Adjustment”

Promoting the upgrading of school-enterprise cooperation from “resource supply” to “strategic symbiosis”:

Establishing an Intelligent Shipping Industry College: Jointly setting up a governance structure with leading enterprises and scientific research institutes, which is responsible for the formulation of training programs, curriculum development, mutual employment of teachers and joint project Research & Development [6].

Implementing the “Dual Supervisor System” and the “Revolving Door System”: Assigning each student an on-campus academic supervisor and an enterprise industrial supervisor; encouraging teachers to take temporary positions in enterprises on a regular basis, and setting up dedicated positions for enterprise experts to teach at the university [6,7].

Establishing a Closed-loop Feedback Mechanism for Talent Demand and Training Quality: Jointly establishing a graduate competency tracking and evaluation system and an industrial technology development early warning mechanism with enterprises, and dynamically adjusting professional directions and curriculum content every year to ensure that education supply evolves in sync with industrial demand [4].

5.5 Implementing a Teaching Staff Transformation Plan of “Simultaneous Introduction and Cultivation, and Cross-Border Integration”

The transformation of the teaching staff is a decisive factor for the success of the reform, and strong measures must be taken:

Implementing the “Teaching Staff Intelligent Literacy Improvement Plan”: Systematically enhancing the knowledge and teaching capabilities of existing teachers in intelligent technologies, data analysis, green energy and other fields through regular on-campus workshops, overseas academic visits and in-depth enterprise research [7].

Vigorously Introducing Interdisciplinary Talents: Setting up special recruitment quotas to actively introduce young talents with doctoral degrees in computer science, artificial intelligence, new energy engineering and other fields who have a strong interest in maritime technology, optimizing the academic background structure of the teaching staff.

Constructing Structured Teaching Teams: Establishing interdisciplinary teaching teams around core directions such as intelligent navigation and green shipping, composed of maritime professional teachers, information technology teachers and enterprise engineers, to realize knowledge complementarity and integrated innovation through collective lesson preparation and co-teaching.

6. Implementation Guarantees and Conclusion

6.1 Guarantee Conditions for Reform Implementation

The effective implementation of the above systematic reform requires solid guarantees through multi-stakeholder collaboration. Policy and standard guarantee is crucial: education administrative departments should collaborate with maritime authorities to study and issue guiding opinions on promoting the intelligent upgrading of maritime majors as soon as possible, and support universities to participate in the formulation and localization of international and domestic standards related to intelligent shipping. Resource and investment guarantee is the foundation: it is necessary to increase special fund investment in new teaching infrastructure such as intelligent maritime training platforms, virtual simulation centers and green technology laboratories. Quality culture guarantee is a long-term driving force: universities should establish an incentive mechanism that encourages teaching innovation and tolerates exploratory practices, and incorporate industrial evaluation into the professional assessment and teacher performance appraisal system to form a quality culture of continuous improvement.

6.2 Conclusion

At the critical juncture where the shipping industry is making a historic leap towards green development, low carbonization and intelligentization, maritime technology education is also standing at the crossroads of transformation and upgrading. This study holds that the traditional, homogenized talent training model can no longer adapt to the emerging shipping industry ecosystem. The future of maritime education must be based on a profound understanding of the essential characteristic of intelligent shipping as a complex system. The core of the reform is to redefine the talent training goal from cultivating “operators” of ships to cultivating “controllers” and “managers” of the intelligent shipping ecosystem. To this end, it is necessary to carry out a comprehensive and in-depth reform covering training goals, curriculum systems, practical teaching, teaching staff and cooperation mechanisms.

The reform framework proposed in this study emphasizes systematic design: guided by the cultivation of “intelligent decision-making” and “cross-border integration” capabilities, it realizes knowledge reconstruction through modular curricula, capability progression through step-by-step practical training, and provides institutional and human resource guarantees through in-depth industry-education integration and teaching staff transformation. This pathway is not a negation of traditional maritime education, but a strategic expansion and upgrading on the basis of adhering to the core values and safety bottom line of maritime navigation. Only through such forward-looking and systematic layout and implementation can the maritime technology major break through development bottlenecks, truly cultivate high-quality talents who can lead the future and support China's grand goal of transforming from a major shipping country to a maritime power, and inject a steady stream of wisdom and vitality into the construction of a maritime power. Future research can further focus on the development of specific curriculum standards, the management model of interdisciplinary teaching teams and the quantitative evaluation methods of reform effects, so as to continuously promote the deepening of maritime education theory and the optimization of practical practice.

References

[1] Li Shixin. China's Navigation Technology Sailing Towards the Deep Blue. People's Tribune, 2025, (20): 106-109.
[2] Wang Jian, Liu Zhengjiang. Current development of intelligent shipping and prediction of talent demand. Navigation of China, 2024, 47(3): 121-126.
[3] He Jianzhong. Technological Innovation Empowers Green, Low-Carbon, and Smart Shipping — Address at the 2025 China Navigation Academic Annual Conference. China Navigation, 2025, 48(4): 1-5.
[4] Zhu Jianhua, Geng Xiongfei. Shaping a New Shipping Ecosystem with Intelligence, Sharing a Future of Safety and Green — Summary of Views from the 2025 China International Ship Technology and Safety Forum. Port & Waterway Engineering, 2025, (8): 1-7.
[5] Yan Xinping. Introduction to the New Generation Shipping System. Wuhan: Wuhan University of Technology Press, 2025.
[6] Yang Shenhua, Xu Liangkun. "Multi-Dimensional and Three-Dimensional": Innovation and Practice of the Talent Cultivation Model for Navigation Technology at Jimei University. Research in Higher Engineering Education, 2025, (3): 112-117.
[7] Yang Xuefeng, Zhou Degui. Record of the Special Teaching and Research Activity on "Professional Transformation and Upgrading of Navigation Technology" Conducted by the Intelligent Navigation Engineering Department. Maritime Education Research, 2025, 42(2): 45-48.
[8] Zhang Xianku, Jia Xinle. Practice and effect of intelligent transformation of maritime majors. Maritime Education Research, 2024, 41(4): 56-61.
[9] Tan Jiawan, Yang Xuefeng. Exploration of Pathways for Deep Integration of Artificial Intelligence and Maritime Education and Teaching. China Education Info, 2025, (10): 78-82.
[10] Bao Xuexin, Zhou Degui. Practical Research on Characteristic Academic Guidance Assisting Navigation Technology Freshmen's Professional Cognition. Education Teaching Forum, 2025, (49): 33-36.

