Domain description

Maritime Operations

Professional profile Maritime Officer

Professional profile Ocean Technology

31-05-2024

Content

Foreword **5**

1 Introduction **7**
1.1 The domain 7
1.2 The maritime sector 8
1.3 Alignment between education and the professional field 9

2 Frameworks and standards **10**
2.1 International professional frameworks 11
2.2 Educational standards 11

3 Social context and developments **12**
3.1 International developments 13
3.2 National maritime innovation policy 14
3.3 Education and research 14

4 Professional profile: Maritime Officer **16**
4.1 Introduction 17
4.2 The professional context 18
4.3 The Maritime Officer profile 20

5 Professional profile: Ocean Technology **28**
5.1 Introduction 29
5.2 The professional context 30
5.3 The Hydrographic Surveyor profile 34

Annex:
1 NLQF, Dublin Descriptors and HBO Standard in relation to domain profile 44
2 Dutch and European qualifications framework 48
3 Companies, agencies and experts consulted 49
4 Sources consulted 50

Foreword

Foreword

This domain description addresses the national framework of study programmes within the Maritime Operations domain. The domain profile contains a professional profile for the two bachelor's programmes 'Maritime Officer' and 'Ocean Technology', providing a framework for the final qualifications for graduates of the respective programmes.

This document replaces the previous domain description from 2016. Developments within the sector in the areas of digitalisation, sustainability, safety and environmental protection are moving at a rapid pace and are having a major impact on professional practices. This requires a regular review process. In 2018, the profile was expanded to include the Electro-Technical Officer position, while this domain description involves a complete review.

Regarding the B Maritime Officer programme, a new Dutch Seafarers Act will come into effect in 2025. Important relevant changes in the act concern the expansion of various certificates of competence for graduates as well as continuing education opportunities.

This updated professional and training profile was created following consultation with representatives from the field who serve on advisory/professional field committees at affiliated universities of applied sciences. An overview of the organisations and individuals from the professional field who were involved has been included in Annex 3.

Maritime Operations domain

May 2024

Inleiding

1

1 Introduction

1.1 The domain

The Maritime Operations domain is one of six technical domains as established by the Netherlands Association of Universities of Applied Sciences. The domain is a relatively small one within higher vocational education. The study programmes are offered by a limited number of universities of applied sciences and offer training for very specific professions.

The Maritime Officer programme is offered by:

- HZ University of Applied Sciences; Technology Water Environment domain;
- Rotterdam University of Applied Sciences; Rotterdam Mainport Institute;
- Amsterdam University of Applied Sciences; The Maritime Academy Amsterdam;
- NHL Stenden University of Applied Sciences; Maritime Institute Willem Barentsz.

The Ocean Technology programme is offered by:

- NHL Stenden University of Applied Sciences; Maritime Institute Willem Barentsz.

By mid-2024, approximately 850 students were pursuing degrees within the domain.

Maritime higher professional education (HBO) is not limited to these programmes. Other programmes in the maritime field include bachelor's and associate degree programmes in Maritime Engineering. These study programmes are related to the Maritime Officer programme, but are part of the Engineering domain.
Two universities of applied sciences also offer maritime master's programmes:

- M Shipping and Transport; Rotterdam University of Applied Sciences; Rotterdam Mainport Institute
- M Maritime Innovations; NHL Stenden; Maritime Institute Willem Barentsz.

This domain description does not apply to these master's programmes.

There is organised, sector-wide consultation between secondary vocational education (MBO) and higher professional education (HBO) institutions, formalised in the 'national maritime vocational education cooperation' structure, to which all providers of maritime vocational education (VMBO, MBO, HBO) are affiliated. Collaboration is necessary in part because of the use of expensive training facilities within maritime education such as simulators, workshops, ships and other practice-oriented facilities. The Maritime Simulator Training Centre (MSTC) on Terschelling is a national facility funded by the Ministry of Education, Culture and Science, where Maritime Officer students from all MBO and HBO educational institutions in the Netherlands undergo about two weeks of training on the full mission simulators.

In the Maritime domain, the continuing education and research pathways are well developed. From the MBO programmes in the Maritime domain, it is possible to progress to the Ad Maritime Engineering and bachelor's programmes. From the various Maritime bachelor's programmes, students can then advance to the master's programmes, either with or without first gaining work experience. This means that there is a continuous pathway leading from the Maritime MBO study programme (NLQF4) to the Ad (NLQF5) and bachelor's (NLQF6), and on to master's level (NLQF7). Recently, this pathway has been expanded to include a Professional Doctorate (NLQF8) programme, which has further strengthened the connection between education and practice-oriented research, in line with the human capital and innovation needs of the sector.

Students in the Ocean Technology programme can advance to various national and international master's programmes in the fields of Geo-Information, Oceanography or Geophysics.

Within the Maritime domain, a maritime lecturer practical research platform has been recently established, with representation from the four universities of applied sciences. In the field of research, there is collaboration between higher professional education (HBO) and university (WO) institutions. Collaboration between lectors and practitioners is currently being explored in more detail, which would provide a final link for both education and research.

1.2 The maritime sector

Both programmes initially provide training for very specific professions: officers on board a seagoing vessel or hydrographic surveyors. These positions have specific international requirements. However, many graduates change careers after a few years, often moving to other areas within the maritime industry. The Netherlands has an extensive maritime sector, including shipping companies, shipyards, design and engineering firms, software developers, legal service providers, research institutions, educational institutions at all levels, as well as a large number of related suppliers.

The turnover for the maritime cluster in 2022 was €95.2 billion. The cluster generated direct added value of approximately €25.9 billion in the Netherlands. There was also €5.2 billion of indirect added value. As such, the Dutch maritime cluster generates about 3.2% (2021: 3.0%) of the gross domestic product (GDP) in the Netherlands. It employed 305,765 workers in 2022, of which the direct labour workforce amounted to 201,914. This means the maritime cluster provides 3.0% (2021: 3.0%) of employment in the Netherlands.

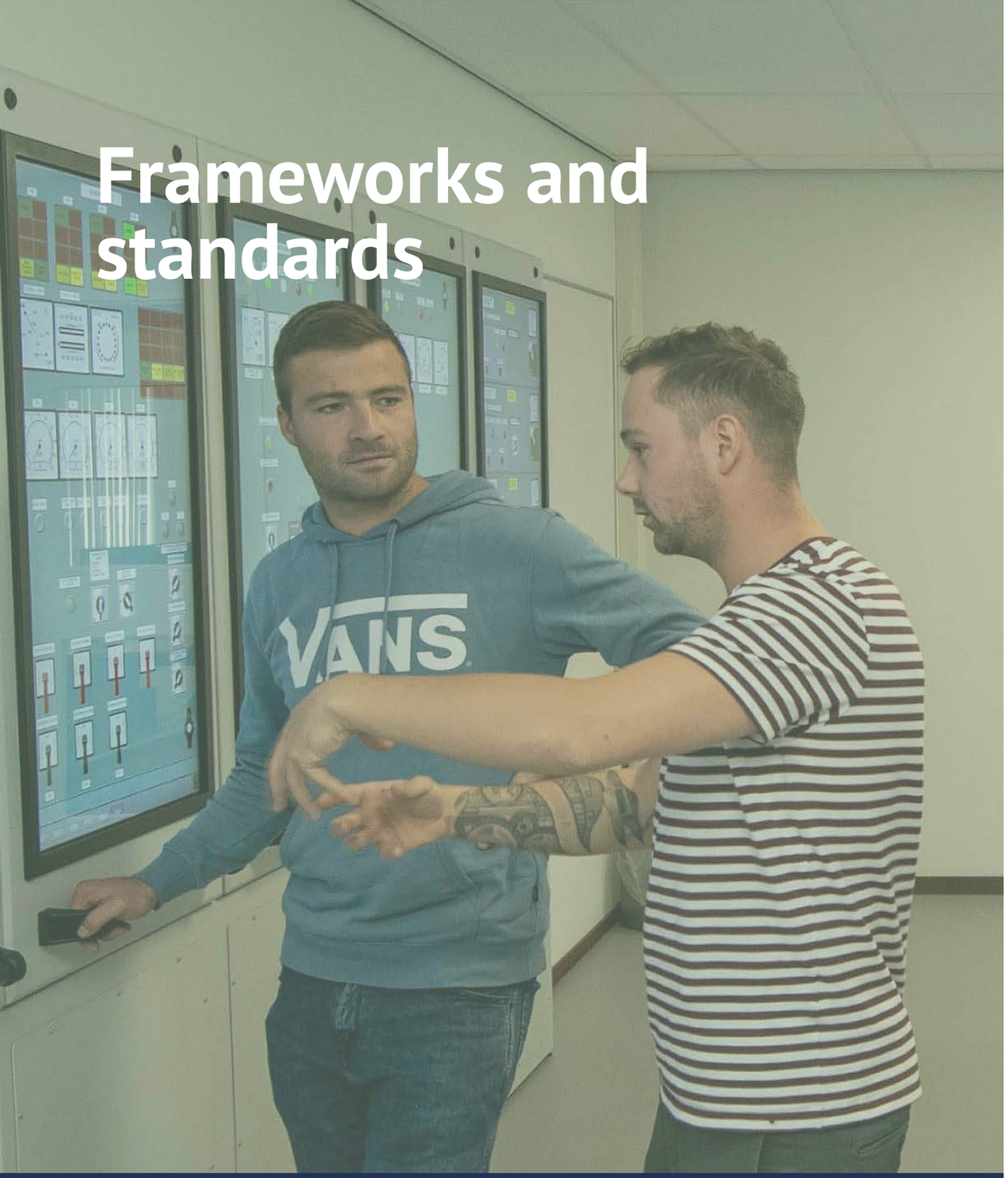
1.3 Alignment between education and the professional field

Given the specific nature of the professions being trained for and the international requirements of the field, intensive consultation is pursued within the domain and among the various stakeholders.

All Maritime Officer programmes participate in the national domain consultation that takes place six to eight times a year on average. In addition to the HBO programmes, the Royal Naval College (KIM) also participates in the national consultation. Due to the strong affinity between the Naval Service Officer training programme in the Royal Netherlands Navy and the Maritime Officer training programme, cooperation and exchange also take place with KIM. This domain consultation involves a regular consultation process at the national level between employers and employee organisations as well as the Ministry of Infrastructure and Water Management.

In addition to regular consultations with companies, the Ocean Technology programme also involves a close relationship to the Hydrographic Service of the Royal Netherlands Navy, which shares responsibility for the international accreditation of the programme.

In addition to consultation with employer and employee associations through the domain consultations, the programmes also have their own advisory committees and professional advisory committee in the professional field. Within these consultative bodies, shipping companies, maritime companies and seafarers are represented in addition to representatives from the aforementioned associations. Represented in the Ocean Technology professional advisory committee are Rijkswaterstaat, the Hydrographic Service of the Royal Netherlands Navy and companies from the offshore offshore, dredging and marine construction sectors. The review of the domain profile was discussed within these bodies. The review process has been explained in further detail in the descriptions of the two specific professional profiles.



Frameworks and standards

2

2 Frameworks and standards

2.1 International professional frameworks

The Maritime Officer Bachelor's degree gives graduates the opportunity to apply for a certificate of competence to serve as an officer on board a seagoing vessel. For this reason, the content of the programmes is determined in part by international requirements based on the *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention)*. The international requirements for the profession of hydrographic surveyor are set out in the *International Standards of Competence for Category A Hydrographic Surveyors*.

2.2 Educational standards

In addition to the international professional standards, there are also a number of standards used within the study programme to substantiate the level of training. The standards below have been incorporated into both professional profiles.

The Dublin Descriptors

Describing the internationally accepted levels for associate, bachelor's, master's and doctoral degrees, the Dublin Descriptors were introduced to make higher education in Europe transparent and comparable. Annex 1 contains the Dublin Descriptors for the bachelor's level.

Dutch Qualifications Framework (NLQF)

The national professional profiles are also related to the general NLQF standards model (Annex 1). The professional roles used and outlined in both profiles are broadly derived from those contained in the NLQF standards.

The HBO Standard

In 2009, universities of applied sciences decided to work together to establish a standard for the professional bachelor's degree. This standard does not replace the Dublin Descriptors or NLQF standards but serves to explicitly articulate the core of the HBO bachelor's degree, and acts as a guideline and framework for the development of national programme profiles and for their interpretation in individual programme curricula. The standard ensures that bachelor's programmes at a university of applied sciences are designed to provide students with a solid theoretical foundation, to foster an inquisitive mindset that enables students to contribute to the development of the profession or of professional products, to ensure that students possess sufficient professional craftsmanship, and finally, to ensure that students develop the professional ethics and social orientation befitting a responsible professional. The HBO Standard can be found in Annex 1.

Social context and developments

3

3 Social context and developments

3.1 International developments

Developments within the maritime sector are currently heavily influenced by a variety of factors, including geopolitical and economic developments, (trade) conflicts, the need for sustainability and fluctuations in energy prices. These elements also play a crucial role in the future of global trade and consequently developments in shipping. But the use of maritime areas by coastal states is also intensifying. One important trend is the growing exploitation of maritime areas, where in addition to traditional oil and gas extraction, more and more wind farms are being installed in coastal areas for example.

Environmental protection, safety and sustainability are becoming increasingly prominent within the maritime industry. International standards related to safety and environmental protection are becoming more stringent, resulting in increasing regulation in this sector. Initiatives such as the limitation of sulfur dioxide (SO2) emissions and targets to reduce CO2 emissions are encouraging far-reaching developments in propulsion technology, the use of alternative fuels, and the implementation of innovative technologies.

In 2019, the International Maritime Organization (IMO), as part of the United Nations, adopted a strategy to work towards the Sustainable Development Goals (SDGs). Given the need to make shipping more sustainable, the emphasis within the IMO is on sustainability, with energy transition as the core theme. One example of the commitment to a more sustainable maritime sector concerns the new IMO regulations for reducing greenhouse gas emissions, with the aim of being emission-free by 2050. Stricter emissions regulations will lead to a number of new technological solutions, including alternative vessels, propulsion systems and fuels. Smart technology is playing an increasingly important role in the pursuit of sustainable and safe shipping.

Alongside these developments, the European Union has also demonstrated its ambitions through the EU Blue Economy policy introduced in 2012. This policy aims to promote sustainable growth in the maritime sector, focusing on economic opportunities and environmental protection. The EU has also recently introduced new requirements for maritime environmental legislation in the transport sector, as outlined in the 'Fit for 55' package. This legislation includes measures to reduce greenhouse gas emissions and introduces the concept of including shipping emissions in the European Union Emissions Trading System (EU ETS).

Another important development is the growing trend toward digitalisation and automation in shipping and hydrography. Implementation of shore support, (semi-) autonomous ships, advanced navigation systems, artificial intelligence and smart shipping technologies is well under way. These developments not only relate to operational efficiency, but also contribute to safety and environmental objectives.

3.2 National maritime innovation policy

In response to these complex developments, the Dutch government and The Top Sector Water and Maritime have formulated an innovation policy as well as targets that focus on emission-free, clean, smart and safe shipping. The maritime agendas align seamlessly with mission-driven innovation policies, with a specific focus on the topics of safety, energy & sustainability, agriculture, water, food and key maritime technologies. These joint efforts are creating a solid foundation for promoting sustainable, safe and advanced developments within the maritime sector, in line with international as well as European objectives. The maritime strategy aims to promote a sustainable international maritime top position for the Netherlands. This means that the policy commitment is focused on an innovative sector, where the need for highly trained, skilled Dutch personnel is increasing. This requires high-quality technical maritime and nautical education and research, both in initial study programmes as well as in continuing education aimed at lifelong development.

3.3 Education and research

The content of the Maritime Officer and Ocean Technology programmes is largely determined by the international diploma frameworks. However, social challenges and the developments described above are increasingly demanding different skills from graduates. Graduates need to have an open, inquisitive attitude that enables them to identify for themselves what they know and do not know or what they can and cannot do in professional situations. They also need to find or create this missing knowledge where necessary with the appropriate thoroughness, making it fit for use for the professional situation in which they work. The ability to collaborate and communicate with other (non-technical) professionals on a multidisciplinary basis is also necessary. Given these rapid developments, especially in the field of digitalisation, knowledge can quickly becoming obsolete. Graduates have to continue to educate themselves in this area and be able to adapt to an environment that is constantly changing. The aim of the programme is to prepare students for this situation. A critical professional attitude centred on lifelong development, adaptability, agility and resilience, is crucial.

As a result, applied research has become an increasingly important part of maritime education. The topics of the (maritime) innovation policy have been translated into research topics within the institutions and are being used to implement new developments within the curricula.

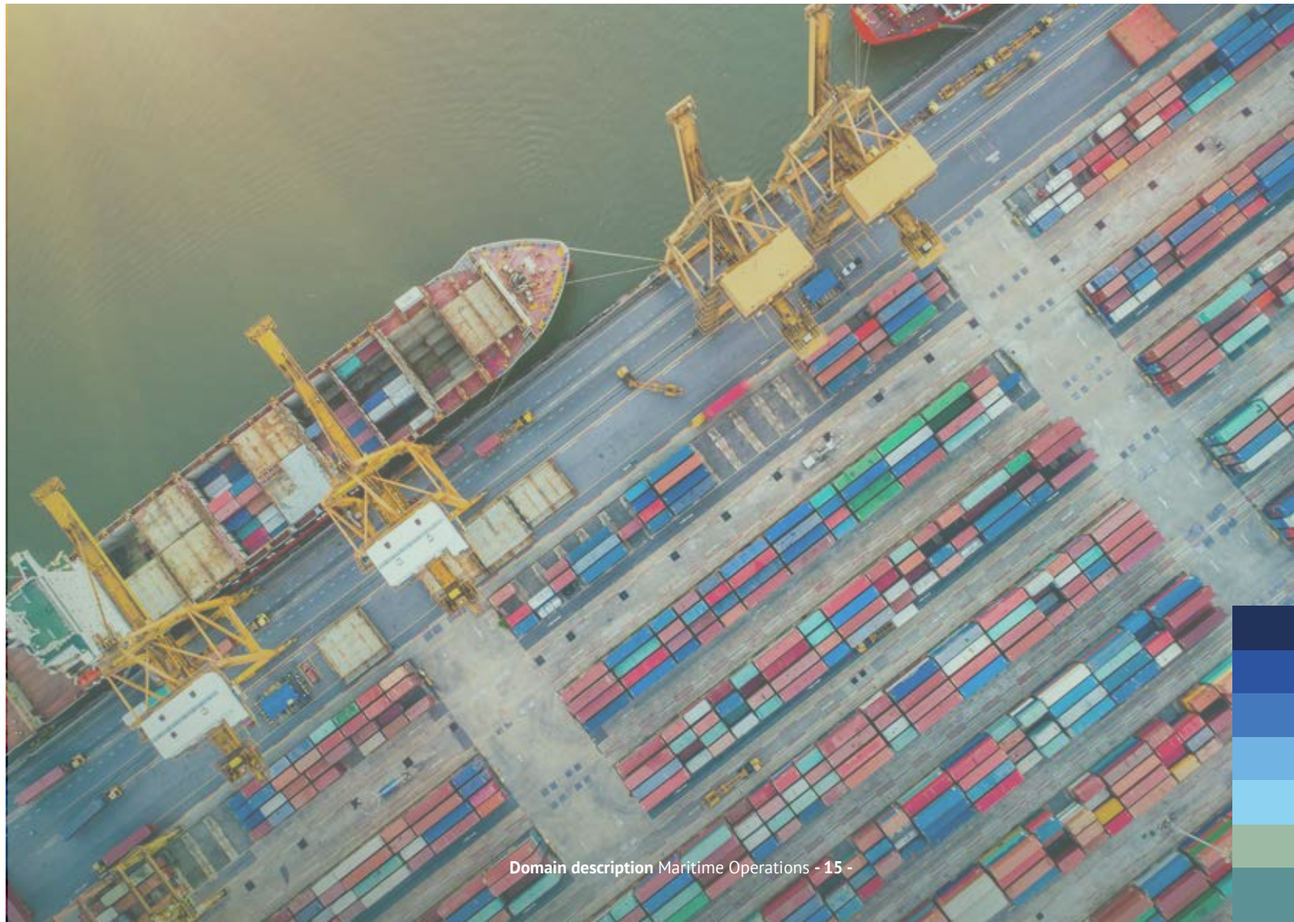
In 2022, cooperation between the four HBO institutions in the field of maritime research intensified with the establishment of the Platform Maritiem Praktijkgericht Onderzoek [Platform for Practice-oriented Maritime Research]. This created a network where not only maritime researchers can work together, but where connections are also being made with other research groups within universities of applied sciences. This is enabling platform participants to work across disciplines and, where necessary, to create crossovers with other domains or to implement specific applications within the Maritime domain. While this collaboration, is generating more mass and synergy in research on the one hand, it also provides the opportunity for each university of applied sciences to focus and specialise. This has also increased the visibility and involvement of maritime HBO education and research, further strengthening the sector. There are also collaborations with TU Delft, the MARIN, the Royal Netherlands Navy, TNO and other universities and research institutions. Links also exist with knowledge platforms that are conducting research in the maritime field as part of MBO education. One important current development concerns the involvement of maritime HBO education and research in the Maritime Master Plan.

We see this reflected within the study programmes in (multi-disciplinary) projects and minors, where crossovers are created with other disciplines such as: Information and Communication Technology and data science, law, civil engineering, and coastal and marine management.

Maritime Master Plan

The Maritime Master Plan focuses on the development, construction, and use of climate-neutral ships. To this end, it aims to develop, build and use 40 reliable and competitive climate-neutral demonstration ships. In doing so, the plan kickstarts the energy transition of the maritime sector in the Netherlands, boosts the Dutch economy and invests in the maritime autonomy of the Netherlands and Europe. A substantial grant has been obtained for the plan from the National Growth Fund.

The Maritime Practical Research Platform has a coordinating role in the formation of learning communities as part of this project's human capital agenda. By doing so, we aim to contribute to this transition and implement the new developments within our education system.



Professional profile Maritime Officer

4

4 Professional profile: Maritime Officer

4.1 Introduction

This professional profile describes the Maritime Officer competence profile pursued by bachelor's programmes. This national profile serves as a guideline for the design of programme curricula. In addition, the programmes from the various universities of applied sciences have the opportunity to develop their own profiles and to define their own priorities within the framework of this profile.

Development of the Maritime Officer programme

Since 1985, seafarers in the Netherlands have been trained to become maritime officers: fully integrated, dual purpose officers on board seagoing vessels. Here, the positions of deck officer, responsible for such tasks as navigation and cargo handling, and marine engineer, with responsibilities for all of the technical installations and systems, have been combined into one position. While the concept of a completely integrated officer was fully embraced in the 1990s, over the years this has fallen out of favour and the positions of deck officer and marine engineer have once again become two separate positions. Some important reasons for this shift included the fact that the Netherlands was unique in this innovative concept. Crew composition has become increasingly international over the years. Since foreign officers had not received integrated training, the concept had to be abandoned. Another important reason was the need for specialisation among officers, particularly on specialised ships in markets such as industry, where the Netherlands has increasingly distinguished itself in recent years.

In reviewing the professional profile in 2016, employers indicated a need for officers with a broad integrated base (nautical and technical), but with specialisation based on obtaining a certificate of competence as either a deck officer or an engineer. In the meantime, a third certificate of competence has been added: Electro-Technical Officer. For several years now, this certificate has been available in conjunction with the Marine Engineering specialisation.

In the meantime, the MBO educational qualifications for Maritime Officer have been revised and a partially integrated version chosen. Here, candidates graduate with two certificates on an 'operational level' and can then pursue their chosen specialisation on a 'management level'.

With this in mind, the Maritime Officer HBO programmes entered into discussions in 2022 with practitioners within the various advisory committees in the professional field. These discussions with the companies were based on the findings from the European SkillSea project. The SkillSea project (2019-2023) sought to address specific challenges within the maritime transport sector and involved 26 parties from 15 different EU countries. These challenges include the shortage of maritime professionals, changing skill requirements due to digitalisation and environmentally conscious transportation, limited mobility between land and on-board positions, and insufficient collaboration among stakeholders regarding skill requirements. The (interim) results from this project provided a sound basis for more in-depth discussions with the professional field concerning desirable skill sets for future graduates.

In addition, since 2019, the programmes have been closely involved in the revision and modernisation of crew legislation through representation on a steering committee of the Ministry of Infrastructure and Water Management. Future legislative changes have been included in this profile.

The final profile was submitted to the Royal Association of Netherlands Shipowners (KVNR), the Dutch Association of Dredgers and Hydraulic Engineers (VvW) and Nautilus International for approval. With regard to the certificates of competence that students obtain, coordination took place not only with the Ministry of Infrastructure and Water Management, but also with the KIWA Register, which is the body responsible for issuing these certificates.

4.2 The professional context

Students taking the Maritime Officer programme are initially trained for an entry-level position as an officer on board ships in the merchant shipping, dredging and marine construction sectors or offshore industries. To serve as an officer on board a seagoing vessel, graduates must apply for a certificate of competence based on their diploma. The content of the programmes meets the international requirements of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, (STCW Convention). This ensures that a certificate of competence is issued based on the school diploma.
In the Netherlands, these requirements are set out in the Dutch Seafarers Act and the accompanying Seafarers Decree, as well as in various regulations. (As of 2025: The new Dutch Seafarers Act, with accompanying decree and regulations). During their studies, students must also have obtained sufficient sailing time in accordance with the STCW Convention and be medically approved for seafaring. They must also hold a range of specific safety and security training certificates. These training programmes are under the direct supervision of the Human Environment and Transport Inspectorate (ILT). Most of the sailing time is obtained on board seagoing vessels during the two internship periods in the programme, with the remaining required sailing time replaced by training on simulators.

4.2.1 The profile

On board the ship, maritime officers are part of a team of ship's officers and perform their duties in a sophisticated and changing work environment. The tasks can be distinguished into operational tasks and management tasks that require HBO qualifications such as research, leadership and communication skills, as well as critical and analytical thinking skills. More and more shipowners are sailing with crews from a wide variety of cultures. This changing crew composition on board ships has made the profession increasingly international in recent years. The complexity of ships and prescribed laws and regulations has also increased in recent years, requiring the officer on board to be a specialist in the operational management of the ship, be it on a nautical or technical level. In doing so, the graduate must be able to advance ultimately to the position of captain or chief engineer.

Although the training is primarily aimed at professional practice on board seagoing vessels, its content and level are such that the experience gained on ships after several years of sailing as well as during postings ashore can be used to fill high-quality shore-based positions in the maritime cluster. Consequently, after several years of work experience, many choose to continue their careers in shore-based positions in the maritime cluster. These jobs can be found within a wide variety of maritime-oriented companies.

4.2.2 Developments in shipping

On board ships, developments in digitalisation and automation have caused major changes in work on the bridge and in the engine room in recent years. Automation and the application of sensors allow more processes to be monitored and optimised from the shore. This allows maintenance to be scheduled more efficiently, for example, but can also save fuel. It is expected that as a result of evolutionary development in the use of automation, the size of the ship's crew will continue to decrease and the use of shore support will experience strong development. In addition to traditionally manned ships, the near future will begin to see ships with greatly reduced crews supported by sea traffic management and shore support, and even autonomous ships within very specific sectors. The Maritime Safety Committee of the IMO recently approved a framework and plan of action for regulatory development, including preliminary definitions of autonomous maritime ships and different degrees of autonomy. In addition to traditional on-board functions, new functions are also emerging in terms of shore support. These new functions, too, require personnel with maritime knowledge and experience.

Sustainability and the need to reduce CO2 emissions will also lead to more differentiation in terms of fuels and propulsion types. The use of LNG, hydrogen, methanol, ammonia and wind support requires specific knowledge from the ship's officer. The problem with this is that in 2024 we do not yet know what the fuel of the future will be and there is a real chance that it will be diverse. In addition to the greater variety of fuels, ship systems will also become more complex due to the use of more electronics.

As a result, there is growing diversification within the fleet in terms of vessel type, propulsion type and sailing area. Within the Dutch fleet, this includes knowledge-intensive sectors and niche services such as offshore, heavy cargo, cruise shipping, dredging and marine construction and gas transport.

4.2.3 Changes in professional practice

The developments outlined above affect professional practice, and the amount of change is only expected to increase and accelerate in the coming years.
Moving forward, there will be a need among Dutch shipowners for officers with a more specialised training, with a broad integrated foundation rather than fully integrated officers. Maintaining this integrated foundation ensures (continued) added value for Dutch officers compared to foreign officers where ship operations are concerned. The new Dutch Seafarers Act also offers more opportunities in terms of certificates of competence, which provides a broad integrated foundation for watchkeeping duties at the operational level in both disciplines.

In addition, increasing complexity and diversity in terms of systems and fuels as well as sustainability are demanding more and more from future ship officers. This involves more than just specific knowledge and skills in fuels, electrical engineering, IT and electronics. Given the rapid changes in technology, the importance of research, analytical and problem-solving skills is also increasing. Moreover, crews work on board in a small team that is mostly composed of international personnel. Maritime officers at the HBO level are distinguished by their leadership qualities, ability to solve complex problems and critical insight into the (working) environment around them. Maritime officers have a good command of the English language and can work well within a team with a changing multicultural crew composition. The officer is independent, analytical, problem-solving, has an inquisitive attitude and, even in complex environments, can adapt to matters easily, and if necessary independently.

4.2.4 Need for lifelong development

The general conclusion is that the international STCW Convention is lagging behind rapid technological developments and that the broad foundation of competence as defined in 2024 may not be sufficient. Specialisations depending on the vessel, propulsion or shipping type will be increasingly in demand. New and complex technologies will also directly affect the competencies and skills required of (future) seafarers. Some of these specialisations will only become relevant after graduates' initial educational training. This means that seafarers will need regular refresher training courses. The new Dutch Seafarers Act already takes this into account and makes it possible to obtain additional certificates of competence for specific positions or types of navigation after completion of the study programme.

4.3 The Maritime Officer profile

4.3.1 HBO level and generic competencies

Graduates of the Maritime Officer programme are primarily professionals with a professional bachelor's degree. This means meeting not only the maritime-related international requirements, but also the requirements of an HBO bachelor's degree. The international level that a bachelor's degree must meet is defined in the Dublin Descriptors and EQF, and on a national level in the NLQF6 and HBO Standard (Annexes 1 and 2). In addition to a solid theoretical foundation, requirements have also been set for professionalism, the ability to apply research skills and professional ethics.

As in all sectors of modern society, the importance of knowledge and innovative capabilities is increasing within the Maritime domain, as outlined in previous sections. An important HBO skill for maritime officers involves the application of research skills. A maritime officer's ability to apply research skills includes both an inquisitive attitude and research skills, where the level is determined by knowledge of methodologies, underlying argumentation, and critical analysis and reflection for the situation and client.

In order to properly perform future professional roles as a maritime officer and to advance to other (future) positions, Maritime Officer graduates must possess seven generic competencies. The following set of competencies has been chosen to achieve both the broader and more in-depth skills desired:

- *Analysing*

Maritime officers are able to analyse maritime topics. This includes identifying a problem or need from the maritime sector, considering possible pathways toward a solution, and identifying objectives and requirements or preconditions unambiguously.

- *Researching*

Maritime officers have a critical and inquisitive attitude and use appropriate sources, methods and techniques to gather and evaluate information and conduct applied research. This research is used for the benefit of professional products/services or professional actions that contribute to solving or improving a practical situation.

- *Improving*

Maritime officers can achieve improvements within a maritime context, working with maritime officers and others. These improvements may involve the operation of a device, process or method, with maritime officers having a sense of the impact of their improvement on the social environment, health, safety, environment, sustainability, and commercial considerations.

- *Managing*

Maritime officers can make a product, service or process function optimally in its application context or work environment, taking into account aspects such as safety, environment, technical and economic life cycle. As part of an international team, maritime officers provide direction and guidance regarding organisational processes as well as to the people involved in them.

- *Communicating*

Maritime officers are able to communicate with colleagues, clients, and other stakeholders using appropriate written and oral means of communication in both Dutch and English.

- *Achieving*

Maritime officers are able to achieve and deliver a product, replacement part or service. They can also provide leadership for the implementation of a process. To this end, maritime officers develop practical skills to solve maritime (maintenance) problems on board the vessel and conduct investigations and tests for this purpose.

- *Professionalising*

Maritime officers are able to master the skills required to effectively carry out the competencies for their field. These skills can also be applied in a broader sense. This includes having an international outlook and being able to relate the latest developments to social norms, values, and ethical dilemmas, for example.

4.3.2 Professional roles and situations: Maritime Officer

This section describes the professional roles and situations that are appropriate to the work of a Maritime Officer (MO) in terms of specific professional practices on board. When reference is made to a seagoing vessel, we are not only referring to a ship that carries cargo or passengers from A to B. Ships carrying out projects in the dredging and marine construction sectors and offshore industries also fall within this general profile. Six tasks can be identified:

1 Conducting safe navigation
2 Ensuring safe loading
3 Managing technical operations
4 Organising and performing maintenance
5 Managing emergencies
6 Ensuring good business practices

1 Conducting safe navigation

Sailing a ship from A to B, requires the essential skills of determining the correct route and navigating safely through it. Therefore, novice MOs are able to perform nautical watch duties proactively, including radio communications. To determine the correct route, novice MOs take into account both the sailing area and economic navigation. With regard to conducting safe navigation, MOs take into account the sailing area, weather conditions, traffic conditions, the safety of the vessel and crew, and the prevailing laws and regulations.

MOs know the influences of these elements and environment on the ship and can recognise them and proactively interpret, implement and translate the information into decisions and policies to be implemented for themselves and/or others. Novice MOs are able to translate and articulate these decisions and/or policies to third parties.

2 Safe loading of the ship

MOs handle the most common types of cargo on the relevant ships. This means loading and/or unloading cargo and taking care of the cargo during the voyage in compliance with national and international regulations, safety and the environment. Cargo also includes passengers.

MOs have knowledge of the different types of cargoes and ships, the stability requirements and the logistics process as well as prevailing laws and regulations. MOs are able to master the relevant requirements using existing literature resources.

In order to load and/or unload cargo, MOs are able to assume a leadership role and collaborate with colleagues and stakeholders as needed.

3 Managing technical operations

The technical systems on board a ship are in place for the purpose of sailing, handling cargo and living on the ship. Managing these systems, requires knowledge of the most common systems, instruments and tools, including electronics, electrical engineering, data, and control engineering.

MOs must be able to operate these installations, troubleshoot any malfunctions, and be able to perform maintenance as needed, or schedule and have third-party maintenance performed. In addition, novice MOs must be able to control, optimise and, where necessary, improve these processes and take ownership of them, either independently or as a part of a team. In doing so, novice MOs have both an operational and a management role, and they collaborate with stakeholders as needed. This allows novice MOs to proactively perform technical watch duties.

4 Organising and performing maintenance

A seagoing vessel is a self-contained environment and it is important for it to remain deployable at all times. Even at sea, damage may occur or repairs may need to be made, so novice MOs must be able to perform or direct these tasks (independently). This may include repairs and maintenance of equipment, installations and structures at sea, at the port and at the dock. It is important for them to be able to communicate and cooperate effectively with the shipping company or any other shore-based parties.

It is also necessary to perform systematic and preventive maintenance to keep the various equipment, installations and structures in good condition. MOs need to have knowledge of the various processes related to maintenance. MOs can perform maintenance as well as plan and direct these processes.

MOs are also able to optimise maintenance processes. In order to plan and manage repairs, it is important for MOs to be able to collaborate with colleagues and stakeholders.

5 Interventions in emergency management

An emergency refers to a situation that threatens the ship, crew or environment. This can include a fire, abandonment of the ship, an illness or personal injury, or a danger of collision. It can also include security-related issues such as cybersecurity, terrorism or piracy. MOs are aware of the available safety and security resources and plans within an organisation and the potential hazards that may occur within these various processes.

MOs are able to act appropriately and anticipate potentially dangerous situations in a professional environment and act in case of emergencies. Here, it is important that they communicate appropriately with the team and any relevant agencies. They are also able to lead exercises to prevent these types of situations, where the behaviour of people involved in such situations plays a central role.

6 Ensuring good business practices

A ship is an enterprise in itself. Central to the management of an enterprise is the continuous pursuit of improvement and sustainability of ongoing (technical) processes. Maintaining a schedule and being able to optimise staffing is a goal in this regard, with crew management and training playing an important role. In this process, MOs need to have an overview of the ongoing processes in the organisation.

MOs must be able to work in multicultural teams: either as a member of the team or as a leader. But they must also be able to operate independently, anywhere in the world, in an international context, with or without the support of or in coordination with a remote office organisation or local external parties. It is also important to take into account extensive legal regulations (environmental and safety) and client requirements.

4.3.3 Body of Knowledge and Skills

The knowledge and skills required are described under the STCW Convention, which is also the basis of the Body of Knowledge and Skills (BOKS) in the programmes. This is used to determine the degree of depth for each programme. The classification of knowledge and skills is also consistent with the tasks outlined in the previous section.
The table below summarises the various relevant sections of the STCW Convention. A distinction is made between operational level (OL) and management level (ML), which depends on the position on board.

STCW section	Description requirements	OL	ML
AII/1	Mandatory Minimum Requirements for Certification of Officers in Ccharge of a Navigational Watch on Ships of 500 Gross Tonnage or More	X	
AII/2	Mandatory Minimum Requirements for Certification of Captains and Chief Mates on Ships of 500 Gross Tonnage or More		X
AIII/1	Mandatory Minimum Requirements for Certification of Officers in Charge of an Engineering Watch in a Manned Engine-Room or Designated Duty Officers in a Periodically Unmanned Engine-Room	X	
AIII/2	Mandatory Minimum Requirements for Certification of Chief Engineer Officers and Second Engineer Officers on Ships Powered by Main Propulsion Machinery of 3,000 kW Propulsion Power or More		X
AIII/6	Mandatory Minimum Requirements for Certification of Electro-Technical Officers	X	
IV/2	Mandatory Minimum Requirements for Certification of GMDSS Radio Operators	X	

The following main degree subjects with corresponding certificates of competence are available:

1 *Semi-integrated nautical;* students graduate with a nautical and technical certificate of competence and are qualified to advance to management level on the nautical side.
2 *Semi-integrated technical;* students graduate with a nautical and technical certificate of competence and are qualified to advance to management level on the technical side.
3 *Semi-integrated technical and electro-technical engineering;* students graduate with a nautical, a technical engineering and an electro-technical engineering certificate of competence and are qualified to advance to management level on the technical side.
4 *Nautical;* students graduate with a nautical certificate of competence and are qualified to advance to the management level.
5 *Technical;* students graduate with a technical certificate of competence and are qualified to advance to the management level.
6 *Technical and electro-technical engineering;* students graduate with a technical and electro-technical engineering certificate of competence and are qualified to advance to management level on the technical side.

To qualify for a certificate of competence, students must have at least the knowledge and skills of the following sections of STCW. For the specialisation, at least the management level of that discipline is obtained and, if necessary, operational level of a counter-discipline can be obtained.

	Nautical/Deck Officer		**Technical/ Marine Engineer**		**Electro-technical engineering Officer**	**Radio communications**
Certificat of	Operational	Management	Operational	Management	Operational	
Competence	STCW AII/1	STCW AII/2	STCW AIII/1	STCW AIII/2	STCW AIII/6	IV/2-
Specialisation						
1 Semi-integrated Nautical	X	X	X			X
2 Semi-integrated Technical	X		X	X		X
3 Semi-integrated Technical + Electro-technical engineering	X		X	X	X	X
4 Nautical	X	X				X
5 Technical			X	X		
6 Technical + Electro-technical			X	X	X	

In addition, the following course certificates are mandatory to qualify for a certificate of competence (the numbers again refer to the appropriate STCW section):

- VI/1 – Basic Training
- VI/2 – Proficiency in Survival Craft and Rescue Boats other than Fast Rescue Boats
- VI/3 – Advanced Fire Fighting
- VI/4 – Medical First Aid
- VI/6 – Security Awareness
- VI/6 – Designated Security Duties

4.3.4 Implementation within the study programme

Interpretations may vary depending on the programme. The ability to use minors to broaden and deepen the HBO programme, has created several opportunities. Some minors are linked, for example, to obtaining an additional certificate of competence (Electro-Technical Officer). In addition, minors will tend to be linked to applied research and the new developments in terms of fuels, as described above. In principle, the way in which majors are implemented within the programme, may differ at each educational institute.

To achieve some uniformity, a number of principles have been formulated:

- In the first two years of study and in the first internship, a broad integrated foundation is to be established, on both a nautical and a technical level.
- After the first at-sea internship, students make a final choice for their major as indicated in the table.
- For a semi-integrated major, both internships should be integrated, i.e. they should include both nautical and technical levels
- Students obtain the certificate of competence based on the major chosen, as stipulated in the new Seafarers Act regulation.
- Students who choose the Marine Engineer major in combination with the Electro-Technical Officer minor and who also complete additional tasks from the Training Record Book may obtain an electrical engineering officer certificate in addition to the Marine Engineer certificate

The nomenclature relating to certificates of competence is uniform and clearly indicated on the diploma. In all cases, the STCW competencies and HBO qualifications defined in this professional profile must be met at a minimum.

Upon successful completion of the programme, students receive an HBO diploma and the degree 'Bachelor of Science'. The diploma (supplement) clearly shows which major was followed and which a certificate of competence can be awarded by KIWA.

Professional profile: Ocean Technology

5

5 Professional profile: Ocean Technology

5.1 Introduction

The professional profile describes the competence profile of the Ocean Technology programme which is pursued by the programme.
The Ocean Technology (OT) programme provides training to become a hydrographic surveyor. The Dutch course has existed since 1979, when the first students enrolled at the Maritime Academy in Amsterdam. Almost from the start, the programme for the four-year full-time HBO course has met the international requirements for hydrographic education and training. In 1983, the first accreditation was issued by the IHO, indicating that the course met the minimum qualifications for Category A. The most recent accreditation (2024) is from 2022, when the existing accreditation was renewed for 6 years. In the Netherlands, the MIWB on Terschelling is the only place where this initial training is offered at the internationally recognised level 'A'. There is also Skilltrade-Nova's commercially driven hydrography course, which trains surveyors to the internationally recognised 'B' level, a practical level comparable to senior vocational level.

As an operational knowledge area, the main task of hydrography is visualising the physical underwater world, especially water depth. Also part of hydrographic expertise are the nature and movements of water and the nature of the seabed. The profession has an international character. When measuring the physical earth, political boundaries only come into limited view. The business sector has assignments around the world that are determined more by natural than by national borders. The language of instruction in the field is English, and virtually all professional literature and teaching materials are in English.

The programme is firmly linked to the professional field through the Ocean Technology professional advisory committee. This is a group of representatives from seven companies and government organisations that meets twice a year to discuss qualitative and quantitative aspects of the profession, the training programme, and the link between them.

The course is internationally recognised as Category A by the IHO/FIG/ICA7. Worldwide, there are 20 Cat. A and 35 Cat. B courses (IHO 2024). Of these, about half are affiliated with a national government agency and only train their own staff. Cat. A has the toughest requirements and trains future 'executives'. The aforementioned Skilltrade is recognised as a Cat. B course and trains up to the 'operational surveyor' level. In addition, there is a Cat. B approved programme in Belgium at the Antwerp Maritime Academy. There is agreement in the professional advisory committee on using the Standards of Competence for Hydrographic Surveyors at the Cat. A8 level; so that HBO graduates optimally meet the requirements of the professional field.

The annual intake is 15-25 students, and in recent years this has seen a decline. The programme is related to geo-information programmes in the Netherlands. Geo-Informatie Nederland provides consultation on the coordination of recruitment efforts. There are also good links with a number of civil engineering programmes, a discipline that often works closely alongside hydrographic surveyors in the construction world.

5.2 The professional context

After a brief description of the general aspects of the profession, four areas of application follow in which at least the Dutch and Flemish professions are strongly represented.

5.2.1 The profile

Hydrographic surveyors work in dredging and marine construction sectors, offshore or for government agencies such as Rijkswaterstaat or the Hydrographic Service of the Royal Netherlands Navy. Based on the international accreditation of the Ocean Technology programme, in accordance with Category A, graduates possess internationally recognised professional competence within the professional field. Consequently, hydrographic surveyors work in internationally oriented professional environments. The work takes place worldwide where, especially in dredging and marine construction sectors and offshore, work is performed in international, multicultural teams and in cooperation with international parties. The language of instruction is generally English.

A hydrographic surveyor is a technical specialist in developing, preparing, conducting, processing and presenting measurements. Measurements are made using modern, state-of-the-art equipment. One defining feature is the use of underwater acoustic measurements where the recorded information is a crucial source of information for navigation safety as well as for properly guiding and controlling construction work above and below water. The recorded data are processed into information products such as maps, digital terrain models and geographic information files that are required to meet the client's objectives and specifications, including accuracy levels.

In addition to depth information, data on the sea floor and objects on and within it such as wrecks, cables and pipes, and unexploded remnants of war, are also collected. Finally, hydrological conditions such as tide/water level, currents and waves are measured for the purpose of own measurements on the one hand and safe navigation on the other, but also as a starting point for civil engineering designs.

In order to properly map the measurements, it is essential that the position at which the measurement was taken be mapped out extremely accurately. This involves the use of highly precise satellite positioning as well as inertial navigation systems and more traditional surveying techniques. The exact shape of the earth and the related geodetic parameters play an important role in converting this information into an accurate and traceable position on the earth's surface. As the accuracy and capabilities of the systems required increase, so too does the need to account for ever-smaller changes to the earth, such as shifting continents and changing sea levels, in horizontal and vertical positioning.

The measurements are taken from ships of varying sizes. In recent years, there has been a trend toward increasingly remote and, where possible, autonomous sailing and measurement. A wide variety of platforms, from underwater robots (ROVs) to autonomous and unmanned surface vessels and flying drones, are being used for this purpose. This has led to a changing role for hydrographic surveyors, from directly observing measurements to planning and controlling autonomous missions. The conditions under which the work must be performed are variable and sometimes nonstandard. This requires not only a high level of technical knowledge of the equipment, but also the practical skills to manage projects under abnormal conditions. In doing so, surveyors are to act in a structured manner according to clear principles and insights, think in a process-oriented manner, and take a systematic and optimised work approach. They are distinguished by their leadership, social skills and management skills. They are independent, analytical, problem-solving and, even in complex environments, can adapt to matters easily, and if necessary independently.

International requirements related to safety and environmental protection are becoming more stringent. As a result, there has been a further increase in regulatory efforts in this area within the maritime sector. Technological, economic and social developments are taking place at an increasingly rapid pace in our society. As a result, knowledge and innovation are becoming increasingly important. Although the programme is aimed primarily at professional practices as a hydrographic surveyor, its content and level are such that the experience gained can be used to fill high-quality positions in the maritime cluster.

Regarding the nature of the work, four areas of application can be defined. The importance of hydrographic work for each of these areas is briefly described in the following sections.

5.2.2 The different areas of application

Government

Hydrography has its roots in the production and updating of nautical charts. Traditionally, this has been a government task. In the Netherlands, this is coordinated by the Hydrographic Service of the Dutch navy. In addition, Rijkswaterstaat has an important duty in the coastal zone and inland waters. Finally, some water boards have the capacity to conduct independent hydrographic measurements. Both Rijkswaterstaat and the water boards also frequently use the services of hydrographic engineering firms (see below). The role of Rijkswaterstaat and the water boards holds a particularly special position in the Netherlands compared to other countries due to the country's low elevation.
Until recently, hydrographers in the Dutch navy were trained in the United Kingdom. However, this programme is no longer available. The navy is now exploring other ways of obtaining recognition for their hydrographers. This includes Skilltrade-Nova's programmes, as well as the MIWB's recently developed international minor 'Hydrographic Surveying and Marine Geodesy'.

Dredging and marine construction sectors

Most employment opportunities for qualified OT students have traditionally been in the dredging and marine construction sectors. Worldwide, Dutch and Flemish dredging companies are market leaders in many respects. Large dredging and marine construction sectors works invariably involve Dutch and Flemish companies. The Dutch firms Van Oord and Boskalis are represented on the professional advisory committee. Examples include the extraordinary land reclamation projects near Dubai, the recently completed widening and improvement of the Suez and Panama Canals and, of course, the expansion of the Maasvlakte. In general, dredging can be subdivided into maintaining the depth of canals and waterways (maintenance dredging), land reclamation, construction dredging and environmental dredging. Dredging and marine construction companies all have surveying departments with several dozen surveyors who support the works worldwide by measuring changes above and below the water. One key aspect of this is determining the progress and quality of the work. This may include determining the volume of material processed and the bed level delivered.

Offshore construction

The third area of application of hydrographic work is offshore construction. This generally involves the installation, inspection, maintenance and removal of the infrastructure that oil companies and electricity companies (wind energy) use to operate at sea. In recent years, an increase can be seen in the focus of dredging and marine construction companies on the

construction of offshore wind farms. There is also the more traditional oil and gas industry. Although the energy transition is well under way, it will be some time before we can do without oil and gas. In the professional advisory committee, Van Oord, Boskalis and Allseas are the representatives of this area of application. Allseas' core business is the installation of subsea pipelines and cables, and in fact, it has the largest vessels in the world for this purpose.
One difference between dredging and marine construction and offshore work is that the latter also makes extensive use of underwater robots that are both autonomous as well as remotely controlled. In many projects, the structure itself and its positioning during construction also play an important role.

Suppliers and engineering firms

In addition to the three main groups mentioned above, there is a wide variety of suppliers of measurement systems and software in the hydrographic world. These all employ hydrographers to support customers and to further develop products according to users' needs. No suppliers are represented in the professional advisory committee, but the study programme regularly consults with these companies on the deployment and use of the systems.
There are also a number of larger and smaller engineering companies operating both nationally and internationally. Of these companies, Fugro and Deep participate in the professional advisory committee group. Fugro is a multinational engineering firm specialising in measurements in and on the earth's crust, and operates primarily in offshore construction. Deep is a relatively young company and, more than Fugro, focuses on executing contracts that can be traced to governments.

5.2.3 Changes in professional development

The work of hydrographic surveyors has traditionally been focused on developing nautical / charts. Developments in this field are of a technical and technological nature, and are also related to international and policy matters. Recent research in the professional field (Hydro International, 2024) reveals the following trends.

Technical innovation

Technical innovation within hydrography is moving at a rapid pace: survey vessels are becoming increasingly autonomous and investments are being made in making 'remote' measurements. This requires a different approach to measurement systems and their remote monitoring. There is also increasing use of measurements by drones for the zone between land and water, which involves techniques that are being scaled down for these applications. This, in turn, has implications for measurement accuracy and data processing. There has also been a further evolution in the techniques that have rapidly emerged over the past two decades, such as high-precision satellite positioning (RTK and PPP), as well as in the multibeam echosounder techniques used. For deep(er) waters, we see an accelerated introduction of inertial navigation systems (INS) in addition to existing underwater positioning systems such as USBL and LBL. These state-of-the-art technologies are creating opportunities for more efficient and precise mapping of the seabed (with increasingly fine resolution).

Data management and analysis

The amount of data collected is only increasing with the use of modern tools and techniques. The flexibility and connectivity of the new tools also enables data linking and interaction between systems. Good data management, including data exchange and the related security, is necessary to unlock the full potential of innovation and to save costs.
As instruments become more innovative, new opportunities are also emerging for analysing the wealth of measurement data and visualising it more powerfully. The use of geographic information systems (GIS) is here to stay. In recent years, research has been conducted on the application of artificial intelligence (AI) and machine learning with hydrographic data as input. Another development in recent years is the 'digital twin', where a digital copy of reality is created using comprehensive data sets. These developments are only expected to accelerate in the coming years. It is not yet clear what role hydrographic surveyors will play here. Will they mainly focus on ensuring that the input data is of sufficient quality and clarity, or will they start to develop their own algorithms to take data processing to the next level? Or will there be, as there has been in the past, a separation between those who obtain the data (hydrographic surveyors) and those who answer complex questions based on the data (hydrographic GIS specialists)?

Personal qualities

With increasing autonomy and remote work, the role of the hydrographer is changing. Where the focus has long been on data collection, it is expected to shift to mobilisation and problem solving in the coming years. This requires hydrographic surveyors who can react quickly and effectively and adapt to this changing situation. It may also create a dichotomy, where there will be hydrographic surveyors who can monitor data quality from anywhere in the world but may never have to set foot on a ship, and, on the other hand, hydrographic surveyors who specialise in solving (technical) problems on site and who travel from project to project in their work.

Collaboration

In the field of hydrography, there is increasing international cooperation and longer and longer chains, partly due to the standardisation and wide availability of the data collected, but also through the use of such technologies as digital twins, where the management process is built around the data collected. This also means increased collaboration with parties outside of the direct professional field of the OT. Knowledge and applications from adjacent sectors can enhance OT. One good example of this is the world of AI, which is fed with hydrographic data. On top of that, there is also civil engineering as a major consumer of hydrographic data in the construction and management process.

Increasing pressure on available maritime space

As human activity at sea expands and shipping continues to grow, the pressure on available marine space is increasing. Stakeholders need to be alert to potential future conflicts that may arise from the further expansion of human activities at sea.

Policy development and implementation focused on the impact of human interventions
With dredging, land reclamation, oil & gas drilling and the construction of wind farms and other forms of renewable energy, human interventions at sea are on the increase. There is a need for policy development and implementation that is focused on the impact of this human intervention on sediment deposits in dynamic seabeds. Hydrographic surveyors play an important role here, which includes providing, analysing and presenting hydrographic data.

Broadening the scope of work

Large parts of the seabed are still unexplored. The Seabed 2030 programme aims to reduce this lack of information by promoting hydrographic surveying. In salvage operations and marine searches, there is a need for more information about oceans and what is found on the seafloor. For example, Fugro conducted research on the missing Malaysia Airlines Flight 370 plane that likely crashed into the Indian Ocean. This search has yielded valuable, previously unknown, information about the Indian Ocean seafloor.

There is also an urgent need for hydrographic mapping of the Arctic Ocean, which is becoming navigable as a result of melting ice. Surveyors are also involved in climate studies to collect and analyse hydrographic data.

5.2.4 Need for lifelong development

The general conclusion is that the professional competencies from the IBSC are lagging behind rapid technological developments and that the broad foundation of competence as defined in 2024 is not always sufficient. Specialisations depending on the application domain will be increasingly in demand. New and complex technologies will also directly affect the competencies and skills required of (future) hydrographers. Some of these influences will only become relevant after graduates' initial educational training, such as with the increase in autonomy and remote data collection. This means that hydrographers will need to participate in regular refresher training courses. Professional accreditation schemes such as the IBSC-recognised multi-national Hydrographic Personal Accreditation Scheme (HPAS) of the International Federation of Hydrographic Societies (IFHS) already take this into account and require a minimum number of hours of professional development per year. It is expected that in the future, additional requirements as mentioned in the HPAS will begin to be imposed on hydrographic surveyors. It is important to reach agreements on this, also in an international context, to ensure that trained hydrographic surveyors can easily continue to meet international requirements.

5.3 The Hydrographic Surveyor profile

5.3.1 HBO and generic competencies

Graduates of the Ocean Technology programme are primarily professionals with an HBO bachelor's degree. This means meeting not only the hydrography-related international requirements, but also the requirements of an HBO bachelor's degree. The international level that a bachelor's degree must meet is defined in the Dublin Descriptors and EQF, and on a national level in the NLQF6 and HBO Standard (Annexes 1 and 2). In addition to a solid theoretical foundation, requirements have been set for professionalism, the ability to apply research skills and professional ethics.

As in all sectors of modern society, the importance of knowledge and innovative capabilities is increasing within the Maritime domain, as outlined in previous sections. A key HBO skill for a hydrographic surveyor involves the application of research skills. This includes both an inquisitive attitude and practical research skills, where the level is determined by knowledge of methodologies, underlying argumentation, and critical analysis and reflection for the situation and client.

1 Analysing

Hydrographic surveyors can analyse relevant practical topics. This includes identifying a problem or need from the broad hydrographic domain, considering possible pathways toward a solution, and identifying objectives and requirements or preconditions unambiguously.

2 Researching

Hydrographic surveyors have a critical investigative attitude and use appropriate sources, methods and techniques to gather and assess information and carry out methodically sound, applied research based on the analysis conducted.

3 Improving and achieving

Hydrographic surveyors can achieve improvements, data products or services within a hydrographic context while working with other disciplines and clients. Data products or services are the result of how hydrographic surveyors perform their task and must clearly meet the client's requirements . These improvements may be the operation of a sensor, (measuring) process, or a measurement or processing method, with hydrographic surveyors having a sense of the impact of their improvement on the social environment, health, safety, environment, sustainability, and commercial considerations. One important aspect of 'achieving' is demonstrating quality through accurate metadata maintenance and careful data management.

4 Communicating

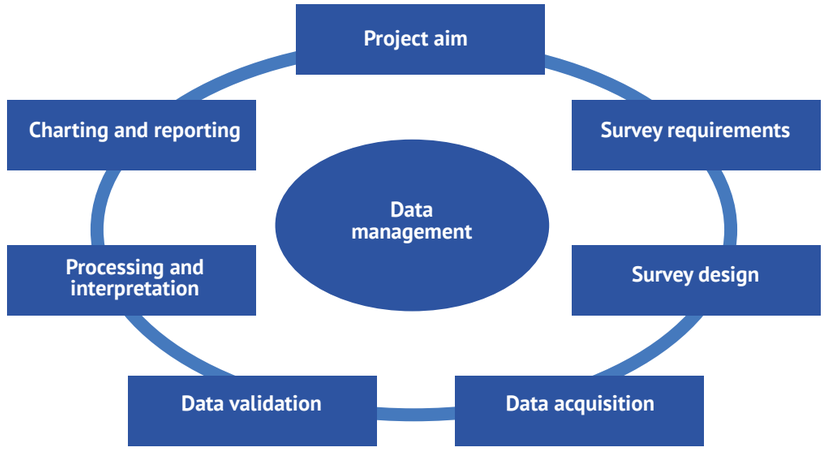
Hydrographic surveyors are able to communicate with colleagues, clients, and other stakeholders using appropriate written and oral means of communication in both English and Dutch. This includes being able to clearly identify needs and opportunities within the immediate work environment or project as well as being able to advise clients when necessary, and effectively managing contractors.

5 Professionalising

Hydrographic surveyors are able to master the skills required to effectively carry out the competencies for their field. This concerns not only professional aspects such as new measurement techniques but also data processing and management of that data. These skills can also be applied in a broader sense. This includes having an international outlook and being able to relate the latest developments to social norms, values, and ethical dilemmas, for example.

5.3.2 The professional role and job performance of hydrographic surveyors

The hydrographic professional field for which Ocean Technology trains new professionals is about helping a client to carry out its main task. This is done through a supply and demand process in which the client's question is converted, through the performance of a measurement, into an answer to that question. The model used for this in the training programme is called the 'hydrographic data circle'.



For the purpose of this profile, a number of steps have been bundled together to create the following steps:

1 Project objective and specifications
2 Measurement design
3 Data collection
4 Data validation, editing and extraction
5 Presentation, reporting and advice
6 Data management

The steps involved in carrying out the duties of a graduate hydrographic surveyor are outlined in detail below.

1 Project objective and specifications

The primary task here is to interpret the client's objective and translate it into measurement requirements. These requirements, in turn, are used to prepare an offer for a survey project.

- Interpretation question: Determining what the actual question is and what products will contribute to answering the question.
- Measurement requirements: Determining how the question translates into requirements for measurement and resulting products.
- Equipment: determining which systems can collectively meet the required specifications.
- Calibrations: determining how the requested equipment will be deployed so that the requirements can actually be met.
- Networking: developing and maintaining a supplier network and deploying it effectively in the specification development process.

- Legal aspects: Handling any applicable legal procedures.
- Time planning: estimating the required duration of a survey based on survey planning and conditions.
- Reservations: documenting the resources required, both internally and with external suppliers.
- Financial: conducting a financial analysis of the technical proposals (and alternatives).
- Health, safety and environment: applying rules and regulations related to HSE.
- Financial guarantees: providing financial guarantees if required.
- Setbacks: designing alternatives in the event that critical survey components fail.
- Aligning specifications internally and externally with relevant stakeholders, refining them where necessary.

2 Measurement design

In this phase, the primary task is to develop and modify equipment, software and procedures to meet the contract specifications.

- Survey manual: translating contractual details into a centrally recorded and updated survey manual.
- Procedures: collecting, analysing, and maintaining all procedures related to the survey project.
- Gathering and understanding equipment manuals and providing training as needed.
- Allocating vessels, personnel and equipment, in subcontracts if necessary.
- Determining what method will be followed for collecting the information and how the environment will affect this data collection (weather, tide, currents, soil conditions, etc.).
- Assessing suitability, including all safety and environmental requirements of the vessels pertaining to the work at hand.
- Organising the timely completion and availability of necessary resources, hardware and software modifications.
- Providing appropriate geometric references (geodetic and elevation datum).
- Verifying that the design is able to meet the specified requirements.
- Agreeing on the design with the client and communicating it to those responsible for implementation.

3 Data collection

In this phase, the primary task is to organise and secure all aspects necessary to conduct the hydrographic survey according to the plan. Here, we see two phases emerging. With increasing trends toward autonomisation and remote work, a dichotomy will eventually be created in the professional field. However, both competencies belong to the Hydrographic Surveyor profile and are therefore important.

Mobilisation of the platform

- Instrumentation: testing the equipment at the company workstation. If necessary, ensuring that appropriate certificates and manuals are available.
- Transport: preparing and verifying a list of all materials and items used. Ensuring that people and measurement resources are available in the right place, at the right time.
- Carrying out the installation, interconnection and testing of survey equipment. This includes proper placement.
- Carrying out calibrations and checking the installed equipment.
- Carrying out tests to verify that all the equipment is ready for data collection and officially marking its completion.

- Solving practical problems that arise so that the platform is suitable for performing the measurements as soon as possible.

Data collection
- Operating and using the survey equipment and software as specified.
- Keeping a survey journal.
- Checking the quality of the survey data if and when possible, both in conventional and less conventional ways.
- Communicating clearly and transparently with clients, ship crew and other members of the measurement crew.

4 Data validation, editing and interpretation
The primary task is translating the raw survey data into a high-quality data set that meets all of the requirements set.
- Checking individual data files for completeness and for any outliers.
- Making a selection from available and suitable automatic processing routines.
- Applying calibration parameters and correcting systematic errors.
- Examining data quality based on customised test parameters and verifying that it meets the specifications.
- Translating the data into the information requested and in the form agreed upon in the contract. Depending on the information requested, this may involve the use of GIS techniques, artificial intelligence (AI) and machine learning.

5 Presentation, reporting and advice
In this final phase, the primary task is to formulate an answer to the original question and to substantiate it with results in the format agreed upon.
- Formulating the answer to the question posed.
- Choosing appropriate routines for the format agreed upon.
- Writing the report.
- Providing proof (verification) that the requested requirements have been met.
- Preparing graphical representations using appropriate software including CAD and GIS programmes.

6 Data management
A lot of data is collected and edited throughout the process. It is the job of hydrographic surveyors to manage this data in such a way that it is always possible to identify how the data were created. There also need to be agreements about access and security to the data as well as (technical) standards that the data must meet in order to be reusable.

- Providing for the management of different types of data in files and databases.
- Always having a current set of metadata available from the data.
- Ensuring that data is captured in a form that can be reused.
- Providing procedures and agreements related to security and reuse of the data.
- Maintaining backup copies of data that can be restored if necessary.
- Creating timely and complete information packages for stakeholders.
- Making data digitally available to others according to the standards agreed upon.

5.3.3 Body of Knowledge and Skills

The foundation of knowledge and skills used during the study programme is based on the IHO document S-5 Standards of Competence for Hydrographic Surveyors, December 2018. Accreditation based on this document should be sought out from the International Board on the Standards of Competence (for hydrographic surveyors and cartographers) (IBSC). This committee evaluates the programme, involving the evaluation of a description of all educational aspects produced by the study programme compared to the standard used by the IGO/FIG/ICA. The international description of study programmes focuses mainly on knowledge and skill requirements. The relationship between theoretical and practical education is also described.

This standard consists of three main topic categories:
- Basic: topics to support content knowledge.
- Fundamental: this refers to specific topics that enhance application in hydrography.
- Hydrographic: this includes the subjects that cover the core of the hydrographic surveyor profession.

The standard describes the following basic knowledge elements:
- B1 Mathematics, statistics and the calculus of observations
- B2 Information and communication technology
- B3 Physics
- B4 Nautical sciences
- B5 Meteorology

At a minimum, basic mathematics includes linear algebra, differential calculus and differential equations, probability calculus and statistics. Basic physics includes kinematics, gravity, magnetism, wave theory, electromagnetic waves, geometric optics, lasers, transducers and clocks.

The knowledge elements referred to in the standards as fundamental science are:

- F1 Earth models
- F2 Oceanography
- F3 Geology and geophysics

Earth models involve gravity and elevation systems, coordinate systems, classical survey principles, levelling, map projections, trigonometry and least squares, estimating the best-fit solution from supernumerary measurements. Oceanography concerns water masses, ocean circulation, the physical properties of seawater, oceanographic observations and waves. Geology includes knowledge about the structure of the earth, geomorphology and the nature of the seafloor. Geophysical knowledge covers gravity fields and gravimetric surveys, magnetic fields and seismic surveys.

Sections on hydrographic science make up the largest group:

- H1 Positioning
- H2 Echo sounders, underwater acoustics and data processing
- H3 LIDAR and remote sensing
- H4 Survey work and applications
- H5 Water levels and flow
- H6 Hydrographic data acquisition and processing
- H7 Management of hydrographic data
- H8 Legal aspects

In addition to the more theoretical topics mentioned above, the inclusion of a 'final project' involving a complex hydrographic (training) survey is a mandatory part of the curriculum implemented.

The classification described above is based on a progressive understanding of the IBSC, and is endorsed in principle by the training institutes recognised by the IBSC such as Ocean Technology on Terschelling. The professional advisory committee group of representatives from the profession has regularly confirmed its desire for programme accreditation.

Personality traits

In addition to the above-mentioned international requirements, ten personal competencies have been formulated in consultation with the Hydrography professional advisory committee group which are necessary for hydrographic surveyors in professional practice. These are as follows:

- Taking initiative: The ability to take effective and proactive action, to participate and speak out.
- Decisiveness: the ability to make quick and appropriate decisions in changing environments.
- Flexibility: the ability to adapt without losing sight of the objectives.
- Resistance to stress: the ability to remain calm in stressful situations.
- Eagerness to learn: continued development as a person, displaying curiosity and openness to feedback.
- Creativity: the ability to suggest alternative solutions, to think beyond known solutions.
- Teamwork: the ability to achieve shared goals in a constructive manner.
- Assertiveness: possessing clear opinions, even when under pressure.
- Persuasion: the ability to convince others of their own point of view, idea or proposal.
- Independence: the ability to work independently, to set and meet their own goals.

These personal characteristics are incorporated into the way the educational training is delivered and the tasks that need to be performed. The Design Based Education concept is appropriate for this purpose. Along with clear feedback, feed up and feed forward, this gives students insight into where they stand in relation to the desired personal competencies in the professional field.

Since surveyors regularly work on board ships, students also take a number of safety training courses during their education. Spending time on board is aimed at improving their understanding of seafarers as customers, but they also receive basic nautical training in addition to an introduction of specific hydrographic topics.

5.3.4 Implementation within the study programme

In the description of vocational training, the training profile and further details on the study programme are included after the visions on the profession and the professional profile. These underlying documents are the responsibility of the programme. The ability to use minors to broaden and deepen the HBO programme has created additional educational opportunities. The main hydrographic process is the most appropriate to use as the basis for the competence profile. The various activities normally carried out by a hydrographic surveyor have therefore been assigned to the phases of the main process. A key part of the study programme is the practical skills that hydrographic surveyors need to possess.

Gradual adjustments can take place in consultation with the professional advisory committee. In addition to recent additions such as data management, the characteristics of a hydrographic surveyor, including personality traits and talents, have also received structured attention.

The programme also includes two final projects, the first of which is conducted at the end of the third year of study. This involves demonstrating professional competence through the execution of a complex, multidisciplinary practical project. The more generic HBO competencies are demonstrated in the fourth year through conducting final thesis research or creating a substantiated final product within the context of a professional organisation.

Upon successful completion of the programme, students receive an HBO diploma and the degree 'Bachelor of Science'. To this end, in addition to the HBO diploma, the graduate will be issued a side letter which clearly states that the graduate has completed a study programme that meets the requirements set by the IBSC for a Category A programme.

Annex

Annex I: NLQF, Dublin Descriptors and HBO Standard in relation to domain profile

European higher education has four consecutive degrees: Associate degree (Ad), bachelor's (B), master's (M) and doctor of philosophy (PhD). The Dublin Descriptors describe the defined level of those degrees in Europe. On a national level, this is secured through the (more detailed) Dutch Qualifications Framework (NLQF). The joint universities of applied sciences in the Netherlands have described a 'standard for the professional bachelor's degree' in the HBO Standard9. This does not replace the Dublin Descriptors but is intended to explicitly articulate the core of an HBO bachelor's degree.

This domain profile and the programme profiles described in it for the Maritime Officer Bachelor's degree and the Ocean Technology Bachelor's degree are in line with the Dublin Descriptors for the bachelor's level and the HBO Standard. Therefore, when students meet the programme profile, they meet both the internationally and nationally accepted level of the respective degree. The overview on the following pages shows the relationship and accountability between them.

NLQF [10]	**Dublin Descriptors**	**Standard for the professional bachelor's degree (The Netherlands Association of Universities of Applied Sciences/HBO Raad)**
Context An unfamiliar, changing living and working environment, including in an international context.		
Relationship to the Maritime Officer and Ocean Technology profiles: The B Maritime Officer and B Ocean Technology programmes train toward an international professional field. There is a focus on developing learning abilities, research skills and being able to use competencies in different contexts. The underlying Body of Knowledge and Skills is internationally recognised. **Maritime Officer:** these competencies are defined so that they can be used in different (national and international) contexts and in different types of professional tasks. **Ocean Technology:** these competencies follow the 'Hydrographic data circle'. This hydrographic data circle and the competence descriptions derived from it are defined in such a way that they can be used in different (national and international) contexts.		
Knowledge Possesses advanced specialised knowledge and critical understanding of theories and principles of a profession, domain of knowledge and broad field of science. Possesses broad, integrated knowledge and understanding of the scope, main areas and boundaries of a profession, domain of knowledge and broad field of science. Possesses knowledge and understanding of several important current topics and specialisms related to the profession or field of knowledge and broad area of science.	**DD 1 Knowledge and understanding** Demonstrates knowledge and understanding of a subject area, building on and exceeding the level achieved in secondary education; Usually works at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study.	**Sound theoretical foundation** Basic knowledge: Dutch, English, arithmetic/mathematics Knowledge base: subject-specific knowledge of the professional domain **Professional craftsmanship** Students learn the knowledge and skills specific to the role of the professional in the (international) professional field and possess an entrepreneurial attitude.
Relationship to the Maritime Officer and Ocean Technology profiles: In both profiles, the Body of Knowledge and Skills used, which along with the competencies is used as the basis for the curriculum, is internationally recognised. **Maritime Officer:** Standards of Training, Certification and Watchkeeping (STCW), at Operational Level or Management Level (see section 3.2 for a specification). The knowledge and skills as named in STCW are supplemented by knowledge of current developments. **Ocean Technology:** S-5-A Standards of Competence for Hydrographic Surveyors of the IHO, the FIG-IHO-ICA IBSC (FIG-IHO-ICA International Board of Standards of Education). The knowledge and skills as named in the IBSC are supplemented by knowledge of current developments.		
Application of knowledge Reproducing, analysing and applying knowledge, including in other contexts, in a way that it demonstrates a professional and/or scientific approach in the profession and/or knowledge domain. Applying specialised skills, including critical and analytical skills, to the outcomes of applied research. Bringing an applied research project to completion, with guidance, based on knowledge of methodologies. Formulating and expanding argumentation. Critically evaluating and combining knowledge and insights from a specific domain. Identifying limitations of own knowledge of the professional practice and/or existing knowledge in the knowledge domain and taking action. Critically analysing and performing complex professional and/or scientific tasks. **Problem-solving skills** Identifying and analysing complex and unpredictable problems in the professional practice and/or in the knowledge domain and solving them tactically, strategically and creatively by identifying and using data **Responsibility and independence** Working together in unfamiliar, changing living- and/or working environments, including in an international context with peers, colleagues, specialists, non--specialists, supervisors and relevant third parties. Taking responsibility for the results of own activities, work and/or study and for the results of others' work. Taking shared responsibility for directing unpredictable processes and the professional development of individuals and groups. Collecting and interpreting relevant data for the purpose of exercising judgment based in part on consideration of relevant social, professional, scientific or ethical aspects.	**DD 2** **Applying knowledge and understanding** Having competences typically demonstrated through devising and sustaining arguments and solving problems in the field of study. Ability to take a professional approach to the work or profession	**Research skills** Students Have the ability to analyse problems Have the ability to synthesise Are solution-oriented Are communicative Have the ability to think and act in a multidisciplinary context **Professional craftsmanship** Students learn the knowledge and skills specific to the role of the professional in the (international) professional field and possess an entrepreneurial attitude.
	DD 3 Making judgments Ability to collect and interpret relevant data (usually in the field of study) to inform judgements. & When making judgements, reflects on relevant social, scientific or ethical issues.	**Research skills** Students possess: Ability to reflect Evidence-based thinking and action-taking skills Innovative capabilities And: Have the ability to analyse problems Have the ability to synthesise Are solution-oriented Are communicative Have the ability to think and act in a multidisciplinary context **Professional ethics and social awareness** This involves an awareness of the meaning of knowledge and skills learned in their social context. Students are expected to possess the ability to critically evaluate knowledge using moral values.

Relationship to the Maritime Officer and Ocean Technology profiles: Performing the professional tasks described in the profiles requires the ability to apply professional knowledge and skills, professional craftsmanship, responsibility, independence, and the ability to weigh various aspects (making judgments) based on social and ethical and social awareness **Relationship to Maritime Officer profile** The ability to apply knowledge and skills in a professional context, combined with research skills and professional craftsmanship, is expressed in many competencies, especially in 'analysing', 'researching', 'improving' and 'achieving'. Responsibility and self-reliance is expressed primarily in the competencies of 'communicating' and 'managing'. The competencies 'improving' and 'managing' express the ability to weigh various aspects and social awareness in making judgments. **Relationship to Ocean Technology profile** The ability to apply knowledge and skills in a professional context, combined with research skills and professional craftsmanship is reflected in many competencies, especially in 'analysing', 'researching', 'improving' and 'achieving'. Responsibility and self-reliance is expressed primarily in the competence of 'professionalising'. The competencies 'improving and managing' express the ability to weigh various aspects and social awareness in making judgments.

Information skills Collecting and analysing, in a responsible, critical manner • broad, in-depth and detailed job-related or scientific information covering a limited set of basic theories, principles, and concepts of and related to a profession or domain of knowledge, • limited information on some key current topics and specialisms related to the profession or areas of knowledge. Presenting this information. **Communication skills** Communicating purposefully based on conventions applicable in the context and professional practice with peers, colleagues, specialists, non-specialists, executives, and/or relevant third parties in the scientific and/or professional community. Adapting communication to the purpose and target audience	**DD 4** **Communication skills** The ability to convey information, ideas and solutions & The ability to convey information, ideas and solutions to both specialist and non-specialist audiences.	**Professional craftsmanship** Students learn the knowledge and skills specific to the role of the professional in the (international) professional field and possess an entrepreneurial attitude.

Relationship to Maritime Officer profile Communication skills are mainly reflected in the competence 'communicating'. Information skills are reflected in the competencies 'analysing' and 'researching'. In 'improving' and 'achieving', aspiring professionals also gather information, theories, models, etc. to come to an analysis and possible solutions. **Relationship to Ocean Technology profile** Communication skills are mainly reflected in the competence 'communicating'. Information skills are reflected in the competencies 'analysing' and 'researching'. In 'improving' and 'achieving', aspiring professionals also gather information, theories, models, etc. to come to an analysis and possible solutions.		
Learning and development skills Using own initiative to develop through self-reflection and self-assessment of own (learning) outcomes.	**DD 5** **Learning skills** Possessing those learning skills that are necessary to continue to undertake further studies with a high degree of autonomy..	**Research skills** Students possess: Ability to reflect Evidence-based thinking and action-taking skills Innovative capabilities
Relationship to Maritime Officer profile This is mainly reflected in the competence 'professionalising'. Investigative and innovative capacity and evidence-based work are reflected in the competencies 'analysing', 'investigating', 'improving' and 'achieving'. **Relationship to Ocean Technology profile** This is reflected in the competence 'professionalising' in particular. Investigative and innovative capacity and evidence-based work are reflected in the competencies 'analysing', 'investigating', 'improving' and 'achieving'.		

Annex 2: Dutch and European qualifications framework

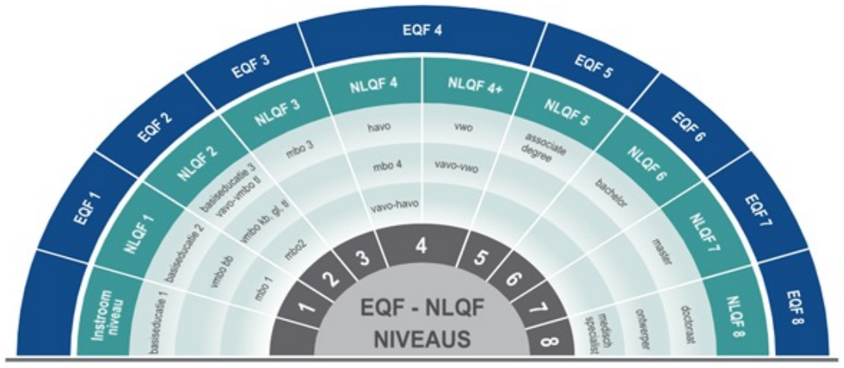


Figure 1.
Schematic representation of the Dutch and European qualifications framework

Annex 3: Companies, agencies and experts consulted

Discussions were held with representatives from:

Maritime Officer

- Nautilus International
- Dutch Association of Dredgers and Hydraulic Engineers
- Royal Association of Netherlands Shipowners

- Multraship
- Holland America Line
- Boskalis
- JR Shipping
- Dutch Pilotage
- Redwise
- OOS international
- Tanker shipping captain
- Visserijbond
- Wagenborg

- Ministry of Infrastructure and Water Management
- KIWA Register

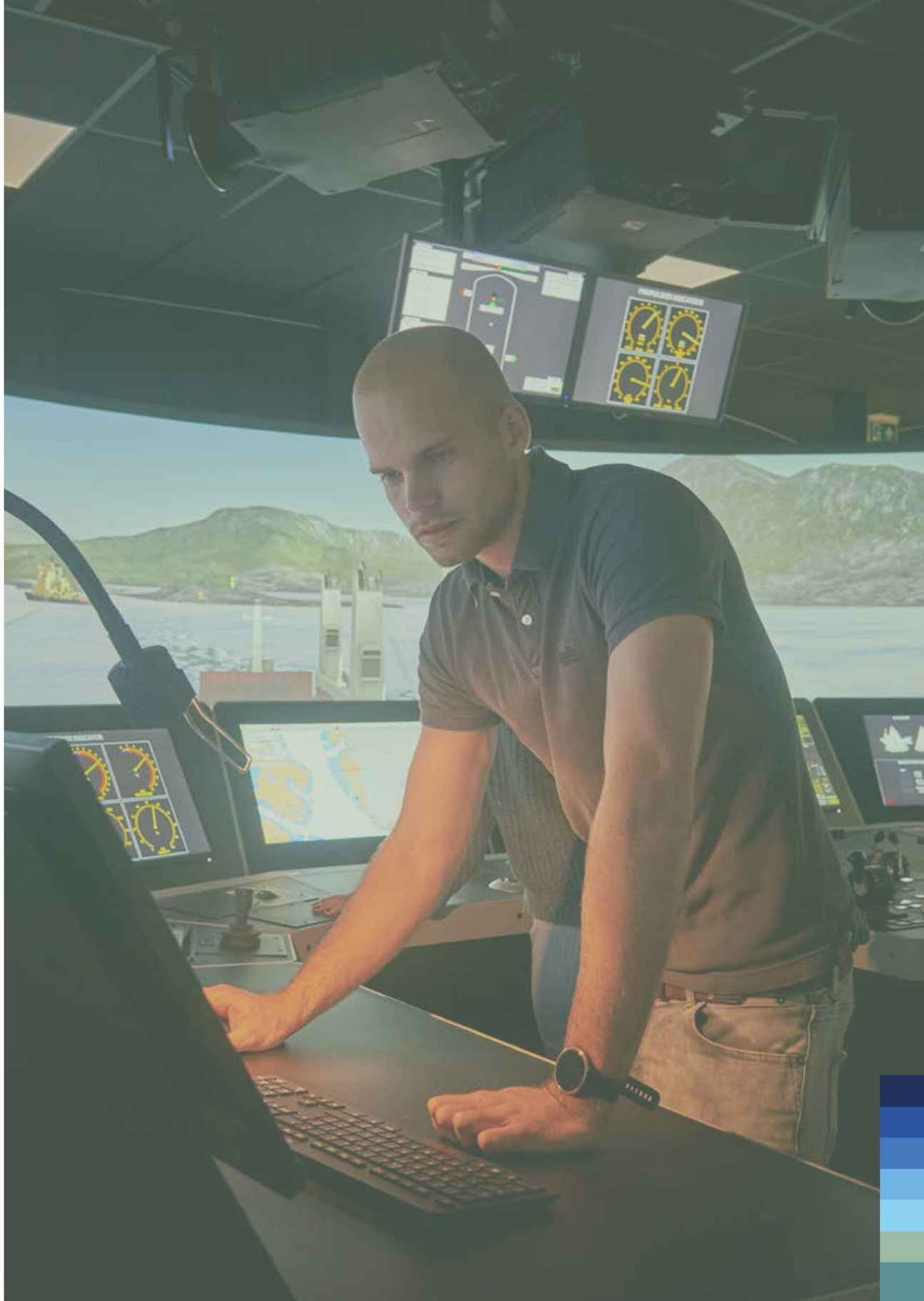
Ocean Technology

- Dutch Association of Dredgers and Hydraulic Engineers

- Van Oord
- Boskalis
- Fugro
- Allseas
- Rijkswaterstaat
- Royal Netherlands Navy Hydrographic Service
- Deep BV

Annex 4: Sources consulted

- The Netherlands Association of Universities of Applied Sciences (HBO Raad), Quality as a mission, HBO Raad, The Hague 2009
- HSBA Hamburg School of Business administration, Seafarers and digital disruption; The effect of autonomous ships on the work at sea, the role of seafarers and the shipping industry, Hamburg/London 2018.
- International hydrographic Organization, Standards of Competence for Category A Hydrographic Surveyors Publication S-5A First Edition Version 1.0.2 – June 2018
- International Maritime Organization, diverse publications on autonomous shipping; https://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx
- International Maritime Organization, International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, IMO London 2011
- Nederland Maritiem Land, Maritieme Arbeidsmarkt en Haven Monitor 2023; *Dutch Maritime Network,* Rotterdam 2023
- NLQF; description level 6, available at https://www.nlqf.nl
- Skillsea, current skills needs, reality and mapping; Rijkeka 2020, available at: https://www.skillsea.eu
- Skillsea, future skill and competence needs, reality and mapping; TRONDHEIN 2020, available at: https://www.skillsea.eu
- World Maritime University, transport 2040; Automation, Technology, Employment, The future of work, WMU 2019
- World Maritime University, transport 2040; Impact of Technology on Seafarers - The Future of work, WMU 2023



Domain description

Maritime Operations