

Origin and Development of Seamanship Competence

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ABSTRACT: Seafaring is one of the oldest documented human activities, with a rich heritage created by generations of seamen. The first boats were developed several thousand years ago, based on primitive principles, and they were probably not suitable for other than simple purposes. Analyzing the history of boat building shows a gradual change in designs. These design changes were most likely due to improvements, related to different aspects of experiences undergone; the changing activity purposes of the boats; and the continual resolution of a conflict between what is possible and what is desired.

Nevertheless, design changes and different improvements were developed in a relationship between experiences gained by sailors and shipbuilders. Therefore, the development of seafaring was probably, both directly and indirectly, based on the experiences of sailors who had gained knowledge of the sea. The first written documentation to support the relationship between sailors and knowledge of the sea is in the Old Testament of the Christian Bible, approximately 950 years before Christ. King Solomon of Israel formed an alliance with the Phoenician king of Tyre, Hiram 1, because he needed the Phoenicians' ships and naval expertise.

"And Hiram sent his servants with the fleet, sailors that have knowledge of the sea, along with the servants of Solomon" (1. King IX – 27).

The phrase "sailors with knowledge of the sea" correlates with a partial core of seamanship science. The science of seamanship is a multi-dimensional expression, which concerns seamen's complete competence in sailing and operating a ship.

The purpose of this article is to discuss the origin and development of the ship-operating aspects of seamanship and shed light on aspects of the development and challenges regarding exercise of seamanship competence-related maritime education and training (MET).

1 INTRODUCTION

Seamanship is a term embracing and affecting all parts of the shipping industry, and it probably relates to all professional operative activities. The main seamanship dimensions – skills, knowledge, and attitude – correlate with the ideals of the term "competence".

Competence is measured by the ability to put into practice the knowledge, skills and attitudes which have been learned and understood. It is this integration in practice which is the crucial part, not simply the acquisition of knowledge and skills [4].

According to the Old Testament [6], the Phoenicians had knowledge of the sea, i.e., one of the seamanship-related dimensions. King Solomon chose

collaboration with the Phoenicians, not just because of their sailing knowledge but also because of their carpentry and shipbuilding expertise and competence. He thus added carpentry and shipbuilding competence to the seamen's knowledge, in addition to the dimensions of ordinary seafarers' offshore operating skills and knowledge. According to this aspect, Werenskiold states that the Viking achievements were only accomplished because of centuries of a systematic transfer of knowledge, excellent seamanship and skillful shipbuilding [30]. With that statement, he also connects shipbuilding achievements with the seagoing knowledge dimensions of seamanship. Carvings and petroglyphs of different large and advanced ship designs illustrate the complexity within different ancient ship designs, Figures 1 and 2.

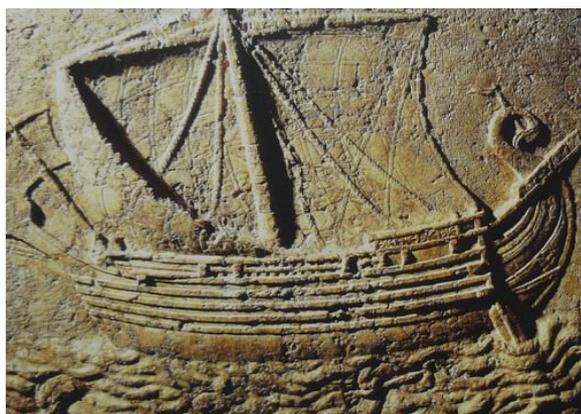


Figure 1. Phoenician ship carved on face of a Sarcophagus, the face 2nd century AD. (Elie plus/CC BY SA 3.0)



Figure 2. Carvings from Alta, Norway. Photo: Alta Museum

If we keep in mind King Solomon's demand for different knowledge dimensions, the science of seamanship then involves both an offshore and an onshore part of the competence dimensions. This study will discuss various developmental aspects of the offshore dimensions of seamanship-related competence, more specifically, seafarers' timeless development of seamanship-based skills, knowledge and human-related behavior (attitude).

The main principal dimensions related to seafarers' offshore operational practices, throughout standard shipping of all ages, could be classified as:

- Navigation – the process associated with voyage planning and the conduct of voyages.
- Cargo – the process associated with the purpose of voyages, such as transport of goods, passengers, weapons and soldiers for warships.

- Maintenance – the process associated with maintaining the ship's seaworthiness before and during the voyage.
- Catering – the process of providing for the crew's needs during the voyage [18].

These main principal dimensions of seafarers' operational practices are based on knowledge and how to use this knowledge in practice. Regarding the ability to use knowledge in practice, the Greek philosopher Aristotle (384-322 BC) expressed the following sentence:

We can have plenty of knowledge, but if something cannot be clearly displayed and used in practice, it's really useless.

Aristotle relates this to the intellectual knowledge forms, *techne*, *episteme* and *phronesis*. *Techne* refers to the practical skills or acts necessary to achieve a defined contextual goal, while *episteme* refers to theoretical and scientific independent knowledge or knowingsness about the context. *Phronesis* refers to how to practice knowledge-based acts, i.e., overall practical wisdom (cleverness) or contextualized knowledge related to developing assessment-based appropriate acts. This form of knowledge is highly dependent on and based on experience-based competence [15].

Phronesis can be associated with seamanship, due to its intellectual virtue-based knowledge associated with performing practice. Aristotle stressed the importance of *phronesis* because of its relevance to intellectual activity in interaction with practice (*praxis*). He argued that *phronesis* occurred in an interaction between the general and the concrete, based on cognitive aspects such as consideration, discretion and choice. Flyvbjerg (2004) expands this, stating that *techne* can be translated or explained as a methodological knowledge or awareness, related to how to use your *phronesis*-based knowledge, i.e., skills, in practice [10].

Aristotle's argumentation about human and intellectual virtue could also easily be associated with the science of seamanship, through his reference to attitudes that make a man good; this goodness may, for example, relate to how seafarers perform their practice. A prerequisite of being able to develop *phronesis* as an intellectual virtue associated with the practice of an art is that one is in possession of accumulated experiential knowledge. This results in basing actions or decisions on careful experience-based assessments that lead to appropriate consequences [15].

Phronesis as a knowledge form can be understood as equivalent to ever-increasing instrumental thinking related to the professional education and professional practice of, e.g., seafarers. It is, therefore, essential to take a step back when practicing professional teaching and education of this profession. Practice of seamanship is perhaps more dependent on practical wisdom than instrumental thinking. There will be no thorough discussions about Aristotle's given philosophical considerations, beyond the argumentation regarding whether there is a relationship between the different knowledge dimensions and seamanship.

2 BACKGROUND

This study is based on the assumption that competence in seamanship represents a form of professional art or ideal of the seafarer's practice. This means art or practice based on maritime education and training, experience, maritime law, rules and regulations, etc. Competence in seamanship links, both directly and indirectly, to humans' behavior while performing their practice. Human behavior sets the standard for all human factor-related performances, including human errors. Both human behavior and human error deal in some way with elements of human psychology. There are many factors related to the seafarer's psychological health. According to MacLachlan [22], stress represents such a factor, probably triggered by perception of risk, challenges and demands that exceed seafarers' available resources. MacLachlan defines maritime psychology as:

The study and practice of the interplay between human behavior and the maritime environment.

The maritime environment related to practicing seamanship competence has undergone some changes, which may have been psychologically challenging for seafarers. Larger and more advanced ships, greater mechanization and reduced manning, followed by subsequent fatigue, represent some examples of such challenges [22].

Different research shows that 75-96 per cent of maritime accidents are directly or indirectly caused by some form of human error [12]. There are different opinions about the underlying causes of these human factor-related accidents. Still, some of these accidents relate to poor situational assessment, situational awareness, forehandedness and practical wisdom, in advance, during and after accidents [16]. The link between the performance of seamanship competence and human factor-based accidents shows that the content or essence of the term "seamanship" should be discussed and nuanced. Clarifying the content and essence is also important because the term is used in different contexts. It is essential to say something tangible about the essence and content of seamanship, because seafarers have been, and still are, convicted of executing bad seamanship.

The most important nautical rules for navigation are covered by the "Convention of the International Regulations for Preventing Collisions at Sea, 1972 (COLREG)". Rule 2 in this convention is designated the responsibility rule, which provides the captain, owner and crew with recommendations and requirements to comply with the other COLREG rules [31]. In addition, Allen [2] designated rule 2 as "The Rule of Good Seamanship and the General Prudential Rule". Allen's designation of Rule 2 represents the prerequisites for the seaman's practice, regarding compliance with the more general COLREG rules [2]. According to International Maritime Organization (IMO), rule 2 requires you to follow both the COLREG rules and "the ordinary practice of seamen":

Your responsibility is not only to follow the COLREGs – you are also responsible for doing everything necessary to avoid the risk of collision and the dangers of navigation. [31]

This means that ship officers on watch must always use common sense, which can be associated with both phronesis (practical wisdom) and good performance of seamanship-based competence.

The United Nations Convention on the Law of the Sea (UNCLOS) [29] requires all nations to ensure that vessels sailing, flying their flag, are at all times in the charge of masters and officers who possess appropriate qualifications in seamanship, fully conversant with the nautical rules of the road. Maritime education and training (MET) must therefore focus on learning outcome related to the seamen's ideal – seamanship – i.e., improving the awareness of human elements and factors.

3 METHODOLOGY

This study was based on a comprehensive and extensive literature research related to existing and relevant research aspects of the current topic that have been chosen to take a closer look at the following objectives: preventing accidents related to human elements.

- 1 Identify the origin, content, core and rationale of seamanship
- 2 Identify development aspects affecting seamanship competence demands
- 3 Identify prerequisites for practicing seamanship competence
- 4 Identify the development of MET related to objectives 1, 2 and 3

Articles and extracts from various books were collected from different online databases, such as Google Scholar, Researchgate, Sciencedirect, UN Convention on the Law of the Sea [29] and the International Maritime Organization (IMO), and then reviewed. The spread across time eras shows the width of the literature search; excerpts from the Old Testament of the Bible and Aristotle's Nicomachean Ethics are examples of how far back in time the study extends.

The first research objective of this study was to identify the origin, content, core, and rationale of seamanship. The reason for this focus is that seamanship-based competence must form a basis for the development of all MET and, in this regard, implement appropriate methods for assessing learning outcomes, based on seamanship-competence-related performances.

The second research objective concentrated on some important developments affecting the prerequisites for practicing seamanship competence related to ship-technical developments, the implementation of rules and regulations and, increasingly, economic and efficiency aspects within the shipping business. This part of the search concerned a review of the literature dealing with possible aspects affecting the practice of seamanship competence, i.e., seamen's knowledge, skills and human-related behavior (attitude), from the 17th century to the present time.

Table 1. Influences related to the development of seamanship competence

Technological advances influencing seamanship competence	Rules and regulations influencing seamanship competence
The use of sextant and chronometer, 17th century	Implementation of the Plimsoll mark, i.e., basis for the Load Line Convention, 1890
From sail to machine propulsion, 18th century	Establishment of the International Maritime Organization (IMO), 1948
The use of gyrocompass, 19th century	Implementation of the SOLAS Convention, 1974
The use of radar, 19th century	Implementation of the STCW-95-Convention, 1978
Communications systems, 19th century	Implementation of the Maritime Labor Convention, Convention on the Supervision of Seafarers' Working and Living Conditions ILO No. 178, 1996
The use of electronic charts (ECDIS), 19th - 20th centuries	
Autonomous marine operations, 19th - 20th centuries	
Automatic Identification System (AIS), 19th - 20th centuries	

Table 1 and Figure 3 show this study's suggestions regarding the factors influencing seamanship-related competence developments, and a scaffold showing some relevant driving forces leading to these influences.

The third research objective for this study concerned the identification of prerequisites for practicing seamanship competence by MET, focusing on human elements. This part of the research concerned a review of the literature dealing with possible human elements that may challenge the performance of seamanship competence.

The fourth research object concerned MET related to a focus on aspects that may have a negative effect on the exercise of the required seamanship-based competence.

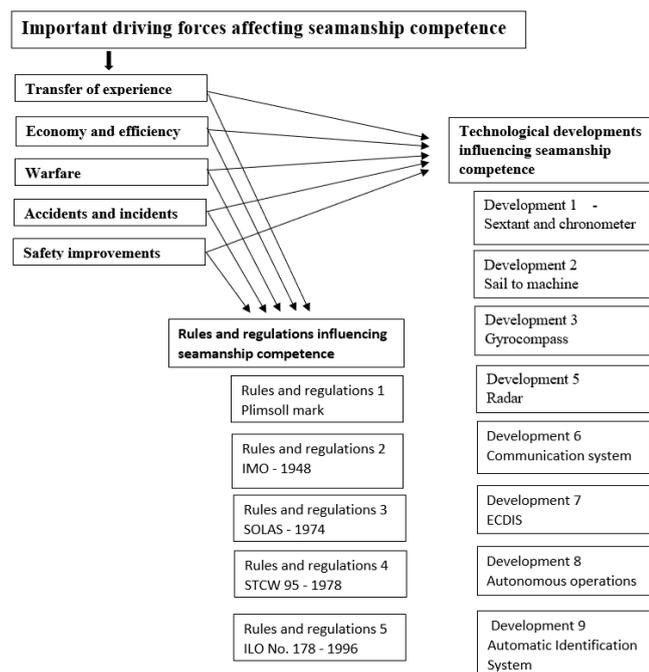


Figure 3. Figure 4. Driving forces leading to the development of seamanship competence

4 DEFINITION OF SEAMANSHIP

A rough definition of seamanship was presented in the Abstract, but the definition is probably more complicated. The executive seamanship competence is based on experiences seafarers, at any given time, have acquired from ancient to present times. These experiences have led to different technological

improvements and innovations in all shipping business dimensions, e.g., shipbuilding and various ship equipment. Wikipedia defines seamanship as:

The art of operating a ship or boat. It involves topics and development of specialized skills including: navigation and international maritime law; weather, meteorology and forecasting; watch standing; ship-handling and small boat handling; operation of deck equipment, anchors and cables; rope work and line handling; communications; sailing; engines; execution of evolution such as towing; cargo handling equipment, dangerous cargoes and cargo storage; dealing with emergencies; survival at sea and search and rescue; and firefighting.

This definition is based on the development of different specialized operating skills, but other definitions balance the content of the science with more human-related aspects.

Knudsen established a relationship between the science of anthropology and seamanship, by introducing the term "anthropship" as an analogy with seamanship. Based on this relationship, Knudsen defined seamanship as:

A blend of professional knowledge, professional pride, and experience-based common sense" [20].

This definition is based more on the connection between aspects of the human element dimension and practicing aspects like operating knowledge and skills. Knudsen's [20] understanding of seamanship has its basis in the context of its use as:

The notation where seafarers unite their professional skills with human competencies and common sense.

"Airmanship is effective decision making to support a sequence of actions."	Training Development Support Unit 2000 [1]
"Airmanship is the care and attitude that you bring to the conduct of your flying. It encompasses consideration for your passengers, care of your aircraft, courtesy to other airspace and airfield users and the self discipline to prepare and conduct your flights in the most professional manner possible. It is not just flying skill that distinguishes a good pilot; it is his or her standard of airmanship."	The Aviation Theory Centre 2001
"Airmanship is a personal and situational management state required to allow a human being to enter and exit, in safety, an environment which they were not naturally designed to inhabit."	Hayes 2002 [2]
"Airmanship is the consistent use of good judgement and well developed skills to accomplish flight objectives. This consistency is founded on a cornerstone of uncompromising flight discipline and developed through systematic skill acquisition and proficiency. A high state of situational awareness completes the airmanship picture and is obtained through knowledge of one's self, aircraft, team, environment, and risk."	Kern 1996 [3]

Figure 4. Definitions, Airmanship training for Modern Aircrew [8]

In some points, seamanship could be compared with airmanship, because both sciences are multi-dimensional terms with an operative approach, which

involves aspects of both cognitive and physical skills, situated knowledge and awareness of self-efficacy and human competence like discipline or attitude. As with seamanship, airmanship has no universally accepted definition. Figure 4 shows some of the expressions that cover the core of airmanship.

Kern [17] explains the essence of airmanship competence, by using an element consisting of six properties:

- 1 Judgment: all elements of airmanship will support good judgment in decision-making. Making appropriate decisions in abnormal and emergency conditions is dependent on appropriate situational assessment. Situational assessment is a trait of airmanship, which shall continuously be developed.
- 2 Situational awareness: the very basis for assessing situations with a view to performing appropriate actions with the desired outcome i.e., to have a perception of what has happened, is happening and may happen ahead (forehandedness).
- 3 In-depth knowledge: a pilot should have broad knowledge, as this will be the nature that supports an airmanship-based mindset.
- 4 Airmanship is founded on skills (expertise).
- 5 Airmanship is founded on proficiency (ability). Good expertise and capabilities in a pilot include both technical and non-technical skills.
- 6 Discipline is the main foundation of airmanship, since it is the basis for the ability and willingness to fly the aircraft safely [17].

These airmanship competence elements form the basis of an Airmanship Model, developed by Kern, as shown in Figure 5.

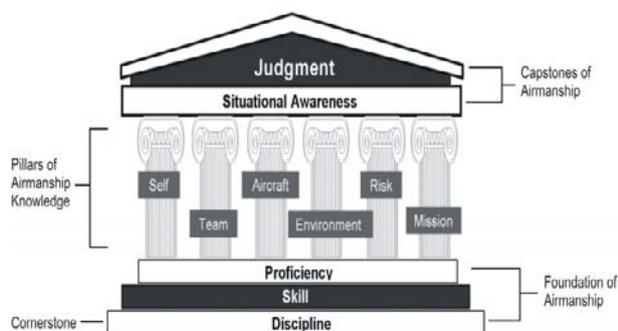


Figure 5. The Airmanship model [17].

In the figure, the pillars of airmanship competence consist of six common areas of different knowledge properties (expertise) of expert airmen:

Expert airmen have a thorough self-understanding of their aircraft, their team i.e., crew, their environment, the risk picture and the mission. When all of these knowledge areas are in place, the expert aviator can exercise a consistently good judgment based on a high state of situational awareness [17].

All dimensions of Kern's airmanship model are comparable to the core of the operative, onboard dimensions of seamanship. The safety aspects of practicing airmanship and seamanship have similarities, like the possible fatal outcome when poor practice is exercised.

The definition of seamanship concerns all mentioned dimensions, but it may relate more to Kern's main principles of airmanship (Figure 6): judgement and situational awareness. Principles of both airmanship and seamanship include a forehanded-based capability of rational thinking, behavioral capabilities and characteristics, combined with good judgment, wise decision-making and self-discipline, etc. These intellectual properties or characteristics may increase the safety elements and minimize the occurrence of underlying or latent human-element related errors; they should, therefore, play a part in the definition.

5 DEVELOPMENT-REVIEW OF "MODERN" SEAMANSHIP PERSPECTIVES

Seamanship reflects characteristics and aspects that usually concern exercising different practices of the seamen's competence, i.e., skills, knowledge and attitude. From the 17th century to the present time, the preconditions for practicing seamanship have gone through some significant changes, both technological and safety-related; see Figures 3 and 4.

One of the most significant technological safety-related advances was probably the introduction of the sextant in combination with the chronometer. This introduction made it possible for sailors to calculate their latitude and longitude, i.e., fix and secure their positions at sea. Positioning at sea was previously random and represented serious safety challenges and possible hazards related to safe navigation.

The shift from sail to machine-powered ships also represented a significant technological upheaval in practicing seamanship. Before this introduction, the art of sail rigging played an important role in the seamen's practice. Rigging sail ships was about handling different parts of the sailing gear and hemp ropes. This rigging competence is no longer required onboard conventional machine-driven ships [3]. Nevertheless, rigging is still used as an expression of making the ship ready for sailing.

Throughout the 20th century until today, various technological developments have made ships more advanced. Some systems have made it possible to sail ships, more or less autonomously, based on advanced data. In addition, modern communication systems have enabled shipping companies to control and take decisions onshore. These developments represent new examples of competence challenges in practicing seamanship in a wise way.

Safety aspects have a significant impact on seamen's security at sea. From ancient times, seamen did not know how long their trips at sea would last or if they would return alive.

The implementation of different safety-related rules and regulations, in combination with better and safer ships, has led to increased probability of seamen returning safely.

One of the first significant contributions to safety and reliable positioning was the implementation of the Plimsoll mark, i.e., the basis for the Load Line Convention [31]. After observing great loss of life and

costs because of shipwrecks during the 18th century, Samuel Plimsoll wrote the book "Our Seamen". This was supposed to shed light on the different causes of shipwrecks, leading to regulations to prevent shipwrecks. According to Plimsoll, overloaded ships were a significant cause of shipwrecking in this period. That motivated him to start a campaign against this problem, because he believed the cause of this loss was easily preventable. Plimsoll's campaign led to the passage of the "Unseaworthy Ships Bill" [27], by making the following appeal to the Board of Trade.

Let provision be made for painting on the ship's side what the Newcastle Chamber of Commerce calls the "maximum load line", and that no ship under any circumstances be allowed to leave port unless that line be distinctly visible at or above the waterline; and let this fact be ascertained and communicated to the Board of Trade by a photograph of the vessel's side as she leaves the port or dock [25].

The International Convention for the Safety of Life at Sea [26] is the most important requirement concerning increased safety on merchant ships. This convention was originally adopted in 1914, as a response to the Titanic disaster of 1912, setting safety standards for the construction, equipping and operation of ships [31].

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW) additionally represents increased safety, by setting standards and requirements for the qualification of ships' officers and other personnel, for merchant ships [31].

The aspects affecting "modern" seamanship competence that are included in this paper are important and selected as examples focusing on competence development.

Despite technological developments, improved safety regulations, and requirement standards, seamanship will always represent a way to perform a practice through wise decision-making, based on situation awareness and assessment.

6 TRANSFER OF SEAMANSHIP COMPETENCE IN MARITIME EDUCATION AND TRAINING

Prince Henry the Navigator established the first MET school in 1419 [7]. In these MET schools, students were educated in navigation, map-making, and science, in order to sail [8]. This establishment marked the start of a gradual change from traditional practice-oriented offshore (learning by doing) fields to more onshore-based learning fields. In modern MET, students are educated in almost exclusive onshore learning fields, followed by a mandatory offshore trainee period, all regulated by the STCW convention.

This study will not discuss any specific learning activities or strategies for how to learn to practice seamanship competence but, rather, prerequisites for executing this competence. MET schools must provide students with an educational outcome, in accordance with meeting minimum STCW qualification standards of competence. Part A of the STCW convention is

mandatory. This part indicates the detailed minimum standards of competence at management, operational and support level, required for seagoing personnel.

Standard of competence is the level of proficiency to be achieved for the proper performance of functions on board ship in accordance with the internationally agreed criteria as set forth herein and incorporating prescribed standards or levels of knowledge, understanding and demonstrated skills [31].

Knowledge, understanding and demonstrated skills related to these prescribed STCW standards correlate with the more operational aspects of performing functions on board a ship, i.e., the ideal of practicing seamanship competence. Ship officer students must prove they have an above minimum standard of competence through MET, before qualifying for the acquisition of a ship officer certificate. This should enable them to practice this competence in a good way. Nevertheless, marine accidents frequently occur, directly as a result of deficient or incorrect use of this minimum standard of competence. However, as mentioned earlier, 75-96 per cent of the underlying causes relate to human elements, leading to human error.

Regarding human elements, Knudsen [20] introduced the concept of anthropship as an analogy with seamanship, based on common features of his own research in human knowledge (anthropology). This analogy represents a connection between human elements and practicing a minimum standard of competence. Human elements become further highlighted in MacLachlan's [22] research volume, which brings together organizational and health psychology within the maritime field. The following issues are examples of important maritime psychological factors [5]:

- Specification of work roles
- Manning hours and ratios
- Working conditions
- Trauma and reactions associated with incidents and accidents
- Fatigue
- Lack of privacy
- Opportunities to socialize, etc.

These maritime psychological factors relate to the occurrence of occupational stress, which, according to MacLachlan et al. [21, 23], is influenced by factors such as the globalization of shipping, increased automation and mechanization of work functions, improvement in navigation techniques, crew number reduction and multicultural crewing, etc. Occupational stress or stress depends on each individual perception of a situation or the assessment of the stressfulness of a situation. This perception can lead to stress-related reactions when individuals perceive that the intensity of stress factors overcomes the ability to cope with these factors.

Knudsen [19], MacLachlan [23] and Carter & Shreiner [5] highlighted aspects of human elements representing prerequisites for practicing seamanship competence.

According to the causal link to maritime accidents made by Hanzu-Pazara et al. [12], there is reason to believe that STCW should focus on and implement

sufficient human element-based requirements in the standard of competence. Therefore, MET schools must consider these requirements, in addition to traditionally prescribed standards or levels of knowledge, understanding and demonstrated skills. The imminent goal regarding this aspect is to give students the best prerequisite to practice proper seamanship competence.

7 DISCUSSION

7.1 General

The science of seamanship is probably a concept or term that holds different philosophical contents. Seamen, who can think and philosophize or reflect, may have better prerequisites for performing good seamanship when challenging situations occur. To be able to philosophize over a term or a concept may give a performer more robustness, accordingly, to think outside the "box".

To carry out daily activities at sea, both individuals and crew must take appropriate situation-based decisions. Not all decisions require thorough active mental processes to assess possible desired outcomes. Some decisions are based on recognizable preferences for choice options, i.e., situations known to individuals and crew based on previous experiences. However, sometimes circumstances will arise where previous experience-based actions do not give the desired solution. In those situations, decisions need to be based on an active mental process of problem exploration and the evaluation of solutions [13]. In the decision-making areas we focus on here, decision-making problems tend to be complex, as the involved choices often interact and provide many solutions, with outcomes that can be difficult to predict [28]. The main seamanship dimension, related to uncertain solution outcomes, may, therefore, be an executive cognitive dimension between different subordinate seamanship-related dimensions and the ability to assess where these dimensions are to be used. Seamanship may thus connect to other disciplines, where the use of different actions must be put in context with the knowledge to assess where to use these actions to perform. This fits well with the features of phronesis, which is a form of situated-based expertise, performed based on knowledge, competence and common sense.

The Wikipedia definition of seamanship does not explicitly mention the words: safety, leadership, humbleness, forehandedness, knowledge, judgment, situation awareness, safety awareness, situation assessment, safety assessment, etc. It just defines technical and skill-based competence aspects of the art of operating a ship or boat. If one sees the seamanship competence exclusively from different views of technical skills or acts, then the human behavior factor and cognitive error aspects will disappear or at least be downgraded.

7.2 Seamanship -developmental aspects (1700 – 2020)

Technological developmental aspects relate first of all to seamen's skills and acts, i.e., how they perform seamanship-related activities. Nevertheless, the overall goal of all mentioned developments, no matter what effect these had on the seamanship dimensions, was safety and efficiency.

Before the introduction of the sextant and the chronometer, seafarers did not manage to fix exact ship positions at sea. Lack of ability to know the ship's position led to major navigational challenges that contributed to insecurity, fear and stress for seamen, regarding safe sailing. The introduction of the sextant and the chronometer became a must for new seamanship-related competence in fixing the ship's position. This development made a major contribution to improving the safety aspects for seamen. The introduction of the gyrocompass, marine radar, ECDIS and autonomous electronic equipment also had the same impact on seamanship, i.e., the introduction of new seamanship-related competences, and a positive impact on safety aspects.

The shift from sail to machine propulsion led to new machine-engineering content of seamanship related competencies and, through that, a goodbye to former sail-rigging competences.

This shift also led to significant changes associated with the human factor. The size of the crew decreased, when shifting from sail- and steam-powered ships to Diesel machine-powered ships. Full-rigged sailing ships needed a large crew, of approximately 50-60 people, just to handle the sailing gear. This was also the case for steamships, which required a large crew to keep a steam machine going. The Titanic engineering crew, for instance, consisted of 317 men: 25 engineers, 10 electricians, 13 stoker foremen, 163 stokers, 73 coal trimmers and 33 greasers. Of these engineers, 249 were directly involved in the steam production: stoker foremen, stokers and coal trimmers (titanicfacts, n.d.). The size of such a large crew on a ship is a challenge because of the possible mental stress from gathering many people in small and closed areas for extended periods. The facilities for the crew on board these ships were not satisfactory, compared to modern standards. Modern ships of the same size as a full-rigged sailing ship or a steamship have a crew of just 10-12 people. It is reasonable to believe that this consideration had an essential degree of impact on the human psychosocial environment, i.e., conditions for the performance of good seamanship. This shift was probably one of the most significant change-makers of these dimensions of the content of seamanship.

Technological developments in communication affected seafarers' way of performing their profession, by enabling, ship-to-ship and ship-to-shore communication. Ship-owners no longer needed to rely on the initiative and skill of the shipmaster to protect their interests. They could now make their own operational and management decisions from their own offices. The shipmaster, who was previously charged with the full responsibility for the success of a voyage, now found his power to carry out his responsibility greatly diminished.

The rapidly increasing quality and availability of radio communications has meant that masters are more and more likely to contact shore managers before reaching decisions. Increasingly, the master is seen as one of a chain of managers, yet his responsibility for the safety of his ship and of those on board has not in any way been reduced by the greater ease of communications [18].

Despite these dimensions of seamen's control of and responsibility for the ship, communication has increased the safety aspects considerably. It has made it possible to, for instance, call for assistance when needed.

The establishment of the International Maritime Organization (IMO) marked the start of an organized regulation of all ship traffic, followed by the implementation of different conventions for the specification of regulations and requirements. The motives were to increase the safety and environmental aspects of all sea activities. The most important IMO conventions related to these aspects are Safety Of Life At Sea (SOLAS), Maritime Pollution (MARPOL) and STCW. One of the first and probably most important positive influences on the safety aspects was the introduction of the Plimsoll load limit mark. In addition to introducing load limit marks, the responsibility for compliance with these marks was now given to the shipmaster. This responsibility was previously determined by the ships' owners, which often led to overloaded and unsafe ships. The introduction of the Plimsoll mark led to a marked decrease in overload-related ship accidents and made the basis for the SOLAS and MARPOL-related Load Line Convention. All these IMO regulations are based on experience from accidents and incidents, with the intention of increasing the safety of seafarers.

Implementation of the Maritime Labor Convention [24], together with economic aspects, has had some impact on seafarers' ability to perform. The MLC was implemented to regulate and secure seafarers' welfare regarding living and working conditions. Since the implementation, different economic aspects have challenged the MLC's content. Previous challenging working conditions were replaced with new ones, led by a growing demand for economically related efficiencies. These aspects have caused some challenging changes, affecting the content of the MLC's five code titles, followed by: increasing workload, decreased crew levels and less time in the harbor [18].

In addition to decreasing in size, ships' crews have become more internationalized through the increased global seafarer labor market. This change has been challenging, as it has increased the language and cultural differences between crew members. Multilingual and multicultural crews have led to the adaption of new knowledge and skills in multicultural understanding, to perform good seamanship [19].

These mentioned aspects of seamanship-related impacts are just a selected number of the most important ones. It is probable that other aspects have also had a great impact, but those mentioned are meant to show only some of the complexity of the development of seamanship.

8 CONCLUDING REMARKS

Seamanship is a term dealing with various practical, cognitive and philosophical aspects that easily could be compared to other disciplines, where the individual professional practice is based on cognitive capacity and overall competence. The quest for seamanship competence is based on a lifelong endeavor regarding experience-based forehandedness, situational awareness, situation assessment, developmental knowledge, practical wisdom, common sense and professional- and prudent judgment, etc.

Flyvbjerg's [9] definition of Aristotle's expression, *phronesis*, relates strongly to the ideal of good seamanship:

The person possessing practical wisdom has knowledge of how to behave in each particular circumstance that can never be equated with or reduced to knowledge of general truths. *Phronesis* is a sense of the ethically practical rather than a kind of science [9].

According to Flyvbjerg [9], *phronesis* requires consideration, prudence, judgment, choice and, above all, experience. It concerns the variable, the particular, the concrete, practical knowledge and practical ethics. *Phronetic* behavior goes beyond analytical rationality and is situational, experience-based, and intuitive. *Phronesis* represents a cognitive capacity, among other things, for choosing the proper situational *techne* (action). According to these considerations, the function of *phronesis* can be a contextual experience-based cognitive-capacity umbrella that results in prudent seamanship-related actions. Effective actions always relate to *techne*-based skills, judgment, understanding, insight and acts according to the technological and scientific epistemic knowledge [11]. This means that all these knowledge dimensions are dependent on each other and influenced by new, both technologically and human factor-based, developments. If seamanship is compared to the Aristotelian knowledge forms, then seamanship will also be affected and continuously in a change, based on the always-scientific developments.

The challenges of any technological development are that "modern seamanship" has more or less transformed every seaman into a form of an automated device that performs increasingly minor and repeated physical and procedural tasks. The complexity of modern ships gives seamen at a certain level (ship officers) large amounts of information, which have been proven to challenge their ability to think, sort, and reflect upon challenges that arise. This complexity has, more or less, transformed traditional practicing seamen into technological operators, subordinate to and managed by the shipping company.

According to King [18], seafarers are no longer the masters but the servants of the technology that makes their seafaring possible. He states that sailors' experience-based skills, knowledge and attitudes have been made redundant or subordinate, by the introduction of new technology and regulations:

The man contributes less in terms of operational decisions and control. Technology has fundamentally

altered the role of seafarers. Wooden ships and iron men, iron ships and wooden men – a sailor’s aside, once used to put down those who chose to serve in the new-fangled steamers, records more than the diminution of human physical prowess [18].

King’s [18] statement could easily be one important factor for the occurrence of unwanted events, because good seamanship practice concerns following new technology and regulations and, on the other hand, deviating from these aspects, according to, i.e., the in-extremis doctrine [1]. Exercising good seamanship may concern the measures that are exercised in situations where deviations from the regulations are the most appropriate.

Admiral of the U.S. Navy, Chester W. Nimitz, made the following observation, regarding the relationship between science, organization and good seamanship:

To ensure safety at sea, the best that science can devise, and that naval organization can provide must be regarded only as an aid, and never as a substitute for good seamanship, self-reliance, and sense of ultimate responsibility which are the first requisites in a seaman [14].

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